Volume 24, Number 2, January 31, 1970

NUCLEAR SCIENCE ABSTRACTS

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

ISHIHARA, T.
Accumulation of fallout ^{137}Cs in newborn infants, 23:50538
ISHIHARA, Toyokuki
Shielding effect of paraffin, water, soil, concrete, Fe, and Pb for high-energy neutrons, 23:51748

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

MELPHALAN
effects on proliferation of cultured antigen-stimulated spleen cells from mice, dose-response curve for, 23:50820
MEMBRANE FILTERS
design for removal of cell-free Streptococcus faecalus from bacteria cultures in fermentation tank, 23:49996 (UCRL-18667, pp 322-9)
MEMBRANES
radiation effects on nuclear, in salivary gland cells of butterfly larvae, 23:50355
radiation effects on permeability of potassium ions through, of mouse ascites carcinoma cells, electron and x, 23:50817
radiation effects on, in mitochondria of intestinal epithelial cells in mice, cobalt-60 γ, 23:50816
MENDELEVIUM
separation from einsteinium and fermium by electrolysis, 23:49772 (UCRL-18667, pp 277-312)
separation from sodium acetate solutions by solvent extraction using sodium amalgam, 23:49772 (UCRL-18667, pp 277-312)
stability of divalent state of, 23:49772 (UCRL-18667, pp 277-312)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. (Los Alamos Scientific Lab., N. Mex.). Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

is indexed as:

LOS ALAMOS SCIENTIFIC LAB., N. MEX.
Fabrication of boron carbide rings and disks, 23:51093 (LA-4164)

Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

JPRS-	**(Non-AEC)**	
46949	23-51587	CFSTI
48330	23-52305	CFSTI
48331	23-52451	CFSTI
48461	23-50889	CFSTI
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KFK-	**(German)**	
743	23-52461	Dep
743	23-52447	For translation see EURFNR-613
781/I	23-52462	Dep
824	23-52397	Dep. CFSTI (U. S. Sales Only)

TABLE OF CONTENTS

Volume 24, Number 2, January 31, 1970

Category	Page
CHEMISTRY	217
Analytical Chemistry	217
Chemical and Spectral Procedures	217
Isotopic Procedures	221
Radiometric Procedures	221
Activation Procedures	222
Inorganic, Organic, and Physical Chemistry	224
Radiation and Nuclear Chemistry	228
Radiochemistry	233
Separation Processes	233
EARTH SCIENCES	238
Geology and Hydrology	238
Meteorology	240
Mineralogy and Exploration	241
Oceanography	241
Seismology	241
ENGINEERING	242
Nuclear Explosions	242
Facilities and Equipment	242
Heat Transfer and Fluid Flow	245
Isotope Technology	248
Materials Testing	249
Radioactive Material Handling	250
Vacuum Engineering	252
INSTRUMENTATION	253
Radiation Detection Instruments	253
General Detectors and Monitors	253
Nuclear Spectroscopic Instrumentation	256
High Energy Physics Instrumentation	258
Radiation Dosimeters	258
Radiometric Instruments	259
Miscellaneous Instruments and Components	260
Radiation Effects on Instruments and Instrument Components	261
LIFE SCIENCES	262
Biochemistry, Physiology, and Molecular Biology	262
Basic Processes	262
Metabolism, Physiology, and Toxicology	263
Radiation Effects	266
Immunology	267
Ecology	269
Genetics and Cytogenetics	271
Health Physics and Safety	275
Radioactive Contamination and Decontamination	275
Dosimetry and Monitoring	276
Radiation Protection	278
Safety Procedures	278
Legal Aspects	279
Medicine	279
Protective Substances	281
Radiation Sickness and Injuries	282
Radiodiagnosis	283
Radiotherapy	285
Radiation Effects on Animals	286
LIFE SCIENCES (Cont'd.)	
Invertebrates	287
Vertebrates	288
Man	292
Radiation Effects on Plants	294
Radiation Effects on Microorganisms	294
Radiosterilization and Radiopreservation	296
METALS, CERAMICS, AND OTHER MATERIALS	300
Metals and Alloys	300
Corrosion and Erosion	300
Preparation and Fabrication	302
Properties Evaluations	304
Structure and Phase Studies	307
Radiation Effects	310
Ceramics and Cermets	311
Corrosion and Erosion	311
Preparation and Fabrication	311
Properties Evaluations	313
Structure and Phase Studies	316
Radiation Effects	318
Plastics and Other Materials	318
PHYSICS (GENERAL)	320
Astrophysics and Cosmology	320
Cosmic Ray Exposure Ages	320
Stars	320
Quasi-Stellar, Radio, and X-Ray Sources	321
Solar Phenomena	323
Galaxies	326
Cosmology	327
Atomic and Molecular Physics	328
Atomic, Electron, Ion, and Molecular Beams and Their Reactions	328
Atomic and Molecular Properties	329
Positronium, Muonium, and Mesic Atoms and Molecules	330
Collision Phenomena	330
Atomic Theory	333
Cosmic Radiation	334
Direct Energy Conversion	335
Fluid Physics	336
Geophysics (Upper Atmosphere)	337
Low-Temperature Physics	338
Plasma and Thermonuclear Physics	342
Confinement and Heating	342
Diagnostics	342
Kinetics (General)	344
Kinetics (Experimental)	345
Kinetics (Theoretical)	347
Production	349
Stability	349
Thermonuclear Processes	351
Wave Phenomena	352
Shielding	355

TABLE OF CONTENTS (continued)

Category	Page
PHYSICS (GENERAL) (Cont'd.)	
Solid-State Physics	355
Radiation Effects	355
Physical Properties	356
Moessbauer Effects and NMR	358
Theoretical Physics	358
PHYSICS (HIGH-ENERGY)	360
Particle Interactions and Properties (Experimental)	360
Electromagnetic	360
Weak	361
Strong (Baryon-Induced)	361
Strong (Meson-Induced)	362
Particle Interactions and Properties (Theoretical)	366
General	366
Electromagnetic	366
Weak	369
Strong (General)	371
Strong (Baryon No. = 0)	372
Strong (Baryon No. = 1)	374
Strong (Baryon No. ≥ 2)	377
Particle Invariance Principles and Symmetries	378
General	378
Applications (Electromagnetic and Weak)	379
Applications (Strong)	379
Field Theories	380
General	380
Quantum Field Theory	380
Gravitation and General Relativity	382
Scattering Theory	384
Particle Accelerators	385
PHYSICS (NUCLEAR)	389
Neutron Interactions with Matter	389
Nuclear Properties and Reactions, A ≤ 5	390
PHYSICS (NUCLEAR) (Cont'd.)	
Nuclear Properties and Reactions, 6 ≤ A ≤ 19	391
Nuclear Properties and Reactions, 20 ≤ A ≤ 89	393
Nuclear Properties and Reactions, A ≥ 90	397
Nuclear Theory	401
REACTOR TECHNOLOGY	405
Commercial Power Reactors	405
Power Reactor Development	408
Kinetics and Dynamics	409
Control Systems	410
Shielding	410
Cooling Systems	410
Fuels	411
Auxiliary and Emergency Systems	412
Operation and Economics	412
Safety and Siting	412
Power Conversion Systems	414
Research and Test Reactors	415
Rocket and Space Reactors	416
Process Heat and Desalination Reactors	417
Marine and Portable Power Reactors	417
Production Reactors	418
Reactor Theory	418
Kinetics	418
Dynamics	420
Experimental Applications	421
Reactor Components, Fuels, and Accessories	422
GENERAL	424
CORPORATE AUTHOR INDEX	INDEX-1
PERSONAL AUTHOR INDEX	INDEX-8
SUBJECT INDEX	INDEX-64
REPORT NUMBER INDEX	INDEX-162

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

2091 (CISE-R-135) REACTOR CHEMISTRY: ANALYTICAL WORK. Topical Report No. 18. Cerrai, Enrico; Triulzi, Cesare; Trucco, Renato (Centro Informazioni Studi Esperienze, Milan (Italy)). July 1965. 96p. Dep. CFSTI (U. S. Sales Only).

Analytical methods applied to determinations on materials of interest in the field of CIRENE programme are described. They consist of chemical procedures, emission spectroscopy methods, and radiochemical procedures. Methods used are fully described and calibration curves reported. (auth)

2092 (CISE-R-151) REACTOR CHEMISTRY: ANALYTICAL WORK. Topical Report No. 7. Cerrai, E.; Triulzi, C.; Trucco, R. (Centro Informazioni Studi Esperienze, Milan (Italy)). Jan 1966. 80p. Dep. CFSTI (U. S. Sales Only).

Analytical methods applied to determinations of materials of interest in the field of the CIRENE programme are described. They consist of chemical procedures, emission spectroscopy methods, and radiochemical procedures. Methods used are fully described and calibration curves reported. (auth)

2093 (IN-1316) ANALYTICAL CHEMISTRY BRANCH ANNUAL REPORT, FISCAL YEAR 1969. (Idaho Nuclear Corp., Idaho Falls). Sept. 1969. Contract AT(10-1)-1230. 291p. Dep. CFSTI.

Separate abstracts were prepared for eight sections of the report. New and revised methods that have been established during the year are reported in detail in the appendix. (J.G.B.)

For abstracts of individual sections see: 2094, 2095, 2098–2102, and 2267.

2094 (IN-1316, pp 60-8) QUALITY CONTROL. Curtis, G. J.; Duce, F. A.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls).

The Quality Control Program is continuing, but significant changes were made in the program for analytical methods. A total of 45 methods is covered currently in the program. The range, unit, and precision of the methods are tabulated. (J.G.B.)

2095 (IN-1316, pp 69-75) UMPIRE QUALIFICATION PROGRAM. Lund, D. M.; Yamamura, S. S.; Rein, J. E. (Idaho Nuclear Corp., Idaho Falls).

The Umpire Qualification Program is continuing, and the status of the following activities reported: participation of AEC, U. S. commercial, and foreign laboratories; preparation of test materials; distribution of test materials to U. S. commercial and foreign laboratories; statistical evaluation of data and preparation of program documents and qualification recommendations; inspection of U. S. commercial laboratories; nondestructive analysis of test materials for the determination of U-235 and Pu-235; and future plans. (auth)

Chemical and Spectral Procedures

Refer also to abstract 2270.

2096 (AERE-AM-110) DETERMINATION OF CARBON IN STAINLESS STEELS. Wicks, D. J.; Jones, I. G. (Atomic Energy Research Establishment, Harwell (England)). July 1969. 13p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

The sample is ignited in O_2 at 1600°C using a resistance-heated furnace and Al_2O_3 boats. ZrO_2 powder is added to prevent attack on the furnace tube by the reacting sample. Evolved CO_2 is collected by condensing at liquid O_2 temperature and its amount is measured manometrically. Sample weights from 0.5 to 0.010 g were used, and weights of carbon determined varied from 5 to 400 μg. See also Cook and Speight (Analyst 83: 144(1956)). (UK)

2097 (CEA-R-3811) DETERMINATION OF SILICON IN A SOLUBLE SILICATE USING AN X-RAY-FLUORESCENCE RADIOISOTOPIC METHOD. Wasilewska, Marta; Robert, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1969. 47p. (In French). Dep. CFSTI (U. S. Sales Only).

A description is given of a spectrometer for x-ray fluorescence analysis having a radioactive excitation source. It was applied to the determination of the silicon contained in an industrial soluble silicate. A theoretical study was made of the operational conditions such as: the effect of the particle size, the dilution of the sample, and the sensitivity as a function of the x-ray excitation energy. It is possible to obtain a relative accuracy of 0.87% for the silicon determination, for one standard deviation. A comparison is made of the sensitivity obtained using this apparatus for the Si determination with that obtained using a conventional apparatus fitted with an x-ray tube. (auth)

2098 (IN-1316, pp 6-35) ANALYTICAL DEVELOPMENT. (Idaho Nuclear Corp., Idaho Falls).

ALUMINUM ALLOYS AND SYSTEMS—Al–U, analysis of intermetallic UAl_3 for α–aluminum oxide, uranium dioxide, and uranium trioxide, x-ray diffraction detection limits for
ELECTRICAL ANALYSIS—reactions at spherical electrodes in, theoretical studies on polarographic kinetic currents for
FISSION PRODUCTS—separation of molybdenum-99 and zirconium-95 from solutions of, radiochemical method for
HAFNIUM ISOTOPES—determination in irradiated hafnium and aluminum–hafnium alloys by mass spectrometry
HYDROCHLORIC ACID—analysis of solutions of, for cobalt, chromium, iron, and nickel by atomic absorption and emission spectroscopy
LUTETIUM-175—determination in irradiated hafnium and aluminum–hafnium alloys by mass spectrometry
NIOBIUM—separation from fluoride solutions of uranium–zirconium fuels by solvent extraction
NITRATES—determination in electrolytic dissolver solutions of stainless steel–uranium fuels
PLUTONIUM—detection of fissionable, in chemical processing plants, design of continuous monitoring system for
REACTOR FUEL ELEMENTS—analysis of ATR, for boron and uranium-235 by spectral methods
—analysis of ETR, for boron-10, silicon, and uranium-235 by spectral methods
THORIUM—determination of trace amounts of, in nickel by spectrophotometry
URANIUM—detection of fissionable, in chemical processing plants, design of continuous monitoring system for
—determination by spectrophotometry, evaluation of β-diketones for
URANIUM ALLOYS AND SYSTEMS—Al–U, analysis of intermetallic UAl_3 for α-aluminum oxide, uranium dioxide, and uranium trioxide, x-ray diffraction detection limits for
(J.G.B.)

2099 (IN-1316, pp 36-40) SPECTROSCOPY. (Idaho Nuclear Corp., Idaho Falls).

A method was developed for the separation of cadmium from solutions of fission products, uranium, and plutonium. Good sensitivity for the cadmium as cadmium iodide was repeatedly obtained with the Hitachi Crucible Source mass spectrometer. A special analytical service was the laser probe analysis of 347 stainless steel by comparing elemental concentrations in metal grains and in the boundaries with a control. A number of new and improved methods and techniques were established. A new technique for ashing Millipore filters for qualitative analysis by emission spectrography was developed. Because of the acceptable low detection limit for beryllium by an emission spectrographic procedure, Millipore filters now are being used instead of the Microsorban filters in air sampling equipment. The Olivetti Underwood Programma 101 was investigated and found inadequate for routine calculations of atomic absorption data. The standard spherical tip electrode used for spectrographic analysis by the vacuum cup technique was modified to a concave form tip to reduce spattering, increase precision, and improve detection limits. An atomic absorption method was developed to replace the emission spectrographic method previously used to determine nickel and chromium in potassium permanganate solutions. Studies are under way on laser sampling for analysis. (auth)

2100 (IN-1316, pp 41-59) CHEMICAL ANALYSIS. (Idaho Nuclear Corp., Idaho Falls).

Work done by the Radio and Special Analysis and the Remote and Service Groups is reported. Air from the TAN-609 battery room was analyzed for arsine and stibine. Air is frequently analyzed for SO_2, and an improved colorimetric method was selected. Methods were evaluated for determining the quantity and size of particulates released from NRTS Boiler House stacks. Blood was analyzed for CO. Coupon decrudding solutions were analyzed for Ni-63. Simulated Purex waste could not be analyzed by existing methods; therefore, other methods were developed to prepare the waste for subsequent analysis. The electrolytic dissolution of EBR-II fuel was analyzed for Fe, Mo, Na, Ru, Si, and U. Black liquor, the waste from paper pulp processing, was analyzed for density, pH, alkalinity, fluoride, phosphorus, undissolved solids, total solids, residue after combustion, total carbon, water, metallic impurities, and various sulfur species. Rover bed samples from the burn-leach process for the recovery of uranium from Rover fuel were analyzed for Al, Al_2O_3, and U. A zirconia-zircon ceramic cement was analyzed for B, Hf, Si, Y, and Zr. Cellulose acetate butyrate plastic strips impregnated with amorphous natural boron were analyzed for B. Fiber-backed tapes were analyzed for S. A method was developed for the separation of Cu from Am in Pu solutions prior to the separation of americium from plutonium; computer analysis of gamma-ray spectra obtained with Li-drifted Ge detectors; determination of gross beta-gamma activity of reactor loop coolant, gross iodine activity, radiocesium, Kr-88 activity, Cs-139 activity, I-133 and I-131 activity, and dissolved oxygen; effect of nitrate on the colorimetric determination of Co; determination of Mo in EBR-II fuel; low-level sulfate; and calculations of radiochemical analysis using the Olivetti Programma 101. Improvements in equipment include installation of a crystal-controlled clock in the Nuclear Data Analyzers to obtain a more stable and accurate time base, fabrication of a remote filtration and fusion apparatus, and fabrication of remotely operated apparatus for sealing glass sample ampoules. (J.G.B.)

2101 (IN-1316, pp 76-84) BURNUP DETERMINATION OF NUCLEAR FUELS. Lisman, F. L.; Maeck, W. J.; Rein, J. E.; Foster, R. E.; Abernathey, R. M.; Delmore, J. E.; Emel, W. A.; Kussy, M. E.; McAtee, R. E.; Workman, G. D. (Idaho Nuclear Corp., Idaho Falls).

The Burnup Determination of Nuclear Fuel Project was completed, and a final report has been issued. Thermal fission yields were measured for 43 mass chains for U-233, U-235, Pu-239, and Pu-241. Fast reactor fission yields were measured for 45 mass chains for U-235 and Pu-239. (auth)

2102 (IN-1316, pp 90-127) LOFT-ECCS SUPPORT PROGRAM. (Idaho Nuclear Corp., Idaho Falls).

The LOFT-ECCS (Loss of Fluid Test-Emergency Core Cooling System) Program is continuing. This program is designed to provide information about loss of coolant accidents to pressurized, water-cooled power reactors. An aluminum can-aluminum lid combination was designed for the packaging and storage of fission product samples. Experiments which indicate that hypoiodous acid volatilizes from aqueous media as a stable airborne species are reported. A sampling device which would measure the concentration of airborne fission products is being evaluated. Materials are being tested for the separation of iodine and iodine compounds from liquid streams. A monitor employing a γ-spectrometric technique was designed to follow airborne concentrations of Kr and Xe on a time-dependent basis. Gas chromatography was used for the quantitative determination of Xe, Kr, iodoethane, and iodomethane. (J.G.B.)

2103 (NIM-440) SEPARATION OF HAFNIUM AND ZIRCONIUM OXIDES FROM URANIUM PRELIMINARY TO THE SPECTROGRAPHIC DETERMINATION OF HAFNIUM. Lagendijk, A.; Russell, B. G.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). Dec. 19, 1968. 4p. Dep. CFSTI (U. S. Sales Only).

The sample is dissolved in HCl, and the Hf and Zr, together with other impurities, are separated from the uranium by liquid-liquid extraction of the cupferron complexes. The hafnium and zirconium are then precipitated with p-bromomandelic acid, and the precipitate is ignited to the oxide and submitted for spectrographic analysis. The procedure is applicable only to ammonium diuranate that has a high degree of purity. The method is adaptable to other pure uranium compounds if the solution technique is appropriately modified. (M.C.G.)

2104 (RFP-1400) TIME-SHARING FORTRAN PROGRAM FOR THE DYNAMIC ANALYSIS OF GASES BY TIME-OF-FLIGHT MASS SPECTROMETRY. Loser, Robert W.; Chambers, Carey A.; Ruby, Evain D. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 7 Nov 1969. Contract AT(29-1)-1106. 15p. Dep. CFSTI.

A time-sharing FORTRAN program is presented for use with a fast scanning mass spectrometer. The program processes mass spectral data to determine the rate at which gases evolve from a solid sample and the total quantity of gas evolved. Calibration data and mass-peak measurements are described as input data. Gas flow rate and gas quantity are described as output data. A description of the gas analysis technique is presented along with the numerical methods used to reduce the mass spectral data. A description of the time-sharing FORTRAN program is also presented. (auth)

2105 SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN U_3O_8 POWDER BY EXCITATION IN HIGH-DENSITY ARGON DISCHARGE. Kleinmann, Imrich; Svoboda, Vratislav (Inst. of Research, Production, and Application of Radioisotopes, Prague). Jad. Energ., 15: 295-8(1969). (In Czech).

A spectrographic method was worked out for the determination of impurities in U_3O_8 in a 60-A direct-current arc in argon atmosphere. The conditions for the optimum excitation of spectral lines of the impurities were investigated. The results were compared with commonly used methods. (auth)

2106 OPTIMUM CONDITIONS OF ATOMIC ABSORPTION, ILLUSTRATED BY MEANS OF THE PERIODIC SYSTEM. von Derschau, H. A.; Prugger, H. Z. Anal. Chem., 247: 8-12(Oct. 15, 1969). (In German).

The 42 most important elements that can be determined by atomic absorption were examined according to a common method in order to establish the most favorable working conditions. The elements of groups IB and IIA and IIB were determined with the highest sensitivity at the lowest possible current of the hollow cathode lamp. All other elements yielded optimum results at maximum lamp current. In the individual groups the flame temperature required for sample evaporation decreased as the period increased. With the elements of group IVA (Ti, Zr, Hf) the evaporation blocking by formation of oxides could be reduced by hydrofluoric acid and, to a lesser extent, hydrochloric acid. (auth)

2107 COMPUTER ANALYSIS OF PHOTOGRAPHED OPTICAL EMISSION SPECTRA. Helz, A. W.; Walthall, F. G.; Berman, Sol (Geological Survey, Washington, D. C.). Appl. Spectrosc., 23: 508-18(Sept.-Oct. 1969).

A recording system and computer can be used for the complete spectrochemical analysis of photographed spectra. Transmission values, taken at equal intervals of travel along the spectrum are transferred to magnetic tape with high precision, high speed, and in a form suitable for computer processing. This processing may include wavelength determination, line identification, and plate calibration. (auth)

2108 PHOTOMETRIC DETERMINATION OF BISMUTH TRACES BY USE OF 7-[α-(o-CARBOMETHOXYANILINO)-BENZYL]-8-HYDROXYQUINOLIN. Roebisch, Gerhard (Paedagogische Hochschule, Potsdam, Ger.). Anal. Chim. Acta, 48: 161-7(Nov. 1969). (In German).

The possibility of extracting trivalent metals (Al, Ga, In, Tl, Bi, La, Cr, Fe(III)) with CMAB-oxine was examined; only bismuth, indium and thallium could be extracted. Differences in the selectivities of oxine, 2-methyloxine and CMAB-oxine are discussed. The composition of the bismuth-CMAB-oxinate is 1:3. Bismuth

can be extracted and determined spectrophotometrically at pH 12.2 ± 0.4; the molar absorptivity at 400 nm is $7.2 \cdot 10^3$. The method is selective and reproducible. (auth)

2109 CATHODE-REGION METHOD FOR THE DIRECT SPECTROCHEMICAL DETERMINATION OF 50 TRACE ELEMENTS IN ROCK PHOSPHATE. Avni, R.; Boukobza, A. (Israel Atomic Energy Commission, Negev). Appl. Spectrosc., 23: 483-9(Sept.-Oct. 1969).

A direct spectrochemical method for 50 trace elements in rock phosphate was developed, exposing only the cathode region (0.5 and 0.8 mm below the upper electrode) instead of the whole dc arc plasma. In the 0.5-mm region 31 elements were analyzed, while the 0.8-mm region was used for Sc, Y, U, Th, Zr, and the rare earths. The axial gradients of the dc arc, burning in air under atmospheric pressure, were studied in order to find the suitable matrix for the trace element standards. The behavior of the temperature, voltage, electron density, line intensity, and particle concentration indicate calcium metaphosphate as suitable matrix for rock phosphate. When 20% by weight graphite was added to both, standards and samples, the detection limits of the traces was in the range of 0.1 to 10 ppM. An average precision of 20% was calculated for concentrations up to 400 ppM. (auth)

2110 RECENT TRENDS IN ANALYTICAL ATOMIC ABSORPTION SPECTROSCOPY. Slavin, Walter; Slavin, Sabina (Perkin-Elmer Corp., Norwalk, Conn.). Appl. Spectrosc., 23: 421-33 (Sept.-Oct. 1969).

Atomic absorption spectroscopy is reviewed especially as to the effect of developments in the past few years on analytical applications. Sources and sampling devices are given special attention. Atomic absorption, flame emission, and atomic fluorescence are compared as to their detection limits and their applicability to analysis. It is shown that the three methods are in many ways complementary rather than competing. The potentialities of resonance spectroscopy are examined and instrument system utilizing resonance methods are described. (auth)

2111 GRAVIMETRIC AND SPECTROPHOTOMETRIC DETERMINATION OF PALLADIUM, RHODIUM, AND RUTHENIUM WITH THIOSALICYLAMIDE. Sur, K.; Shome, S. C. (Presidency Coll., Calcutta). Anal. Chim. Acta, 48: 145-53 (Nov. 1969).

Thiosalicylamide is proposed for the gravimetric and spectrophotometric determination of palladium, rhodium, and ruthenium. The precipitates formed with palladium, rhodium, and ruthenium can be dried at 110 to 120°C for direct weighing and correspond to $Pd(C_7H_7ONS)_4Cl_2$, $Rh(C_7H_8ONS)_3$, and $Ru(C_7H_8ONS)_2$, respectively. Palladium can be separated from rhodium or ruthenium in highly acidic solution; under suitable conditions, Co, Ni, Mn, Fe, Zn, Mo(VI), W(VI), Al, Ga, In, V(V), Ir, etc., do not interfere. The metal–thiosalicylamide complexes form colored solutions in common organic solvents, so that spectrophotometric determinations are possible. The Pd complex is dissolved in 50% ethanol whereas the rhodium or ruthenium complex is extracted with a mixture of isobutyl methyl ketone and ethanol. Maximum absorbance is obtained at 350, 380, and 390 nm, and the molar absorptivities are 39,300, 7000, and 6330 for the Pd, Rh and Ru complexes, respectively. Few ions interfere. (auth)

2112 THIN-LAYER CHROMATOGRAPHY IN INORGANIC ANALYSIS. COMMUNICATION 6. DETERMINATION OF THE RARE EARTH ELEMENTS IN URANYL NITRATE OF HIGH PURITY. Volynets, M. P.; Vagina, N. S.; Fomina, T. V.; Fakina, L. K. Zh. Anal. Khim., 24: 1477-9(Oct. 1969). (In Russian).

A method was developed for determining $n \times 10^{-5}$ to $n \times 10^{-3}$% of the rare earths in uranyl nitrate after the separation of uranium and the rare earths by the method of ascending thin-layer chromatography. The determination was carried out spectrophotometrically using Arsenazo III or Arsenazo M. (auth)

2113 ZONE ELECTROPHORESIS ON PAPER IN INORGANIC ANALYSIS. COMMUNICATION 3. AN EXPRESS METHOD FOR SEPARATING THORIUM, RARE EARTH ELEMENTS, AND URANIUM IN MINERALS AND THEIR PHOTOMETRIC DETERMINATION. Korchemnaya, E. K.; Naumova, V. I.; Ermakov, A. N.; Nemodruk, A. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 24: 1515-20(Oct. 1969). (In Russian).

A rapid electrophoretic method is suggested for separating thorium, rare earth elements, and uranium from monazite and orthite indexed as allanite. The method is based on the different migration rate of the elements on paper in a 0.05M solution of citric acid. Elements in their zones are determined photometrically with Arsenazo III. The possibility of using the method of zone electrophoresis on paper as an analytical method is discussed. (auth)

2114 RADIOISOTOPE X-RAY TECHNIQUES FOR ON-STREAM ANALYSIS OF SLURRIES. FEASIBILITY STUDIES USING SOLID SAMPLES OF MINERAL PRODUCTS. Ellis, W. K.; Fookes, R. A.; Gravitis, V. L.; Watt, J. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Int. J. Appl. Radiat. Isotop., 20: 691-701(Oct. 1969).

Radioisotope x-ray fluorescence and preferential absorption methods for analysis or mineral products are described. These techniques were used to determine zinc, copper, tin, and lead in concentrate, flotation feed, tailing, and residue samples taken from mineral processing plants. The precision of analysis for solid samples was in the range of 1 to 10% of the mean element concentration except for copper in tailings. The application of these techniques to on-stream analysis of slurries should result in similar precisions. (auth) (UK)

2115 SPECTROPHOTOMETRIC DETERMINATION OF TRACE AMOUNTS OF TITANIUM(IV), ZIRCONIUM(IV), AND THORIUM(IV) WITH MOLYBDOPHOSPHORIC ACID SOLUTION. Murata, Katsuo; Yokoyama, Yu; Ikeda, Shigero (Osaka Univ.). Anal. Chim. Acta, 48: 349-56(Dec. 1969).

Trace amounts of titanium(IV), zirconium(IV), and thorium(IV) ions were determined spectrophotometrically with molybdophosphoric acid solution. The method is based on the formation of the ternary heteropoly complex by reaction of the metal ion with molybdophosphoric acid, and elimination of unreacted acid by extraction with n-butyl acetate. Beer's law was obeyed over the range 1 to 7 ppM of metal ion. These ternary heteropoly complexes have the composition of Me : P : Mo = 1 : 1 : 12. The formation constants increase in the order, molybdotitanophosphate, molybdothorophosphate, and molybdozirconophosphate. (auth)

2116 MEASUREMENT OF SMALL DEVIATIONS FROM STOICHIOMETRY OF URANIUM DIOXIDE. Viguie, J. C.; Chabert, J. P. (CEN, Grenoble, France). Anal. Chim. Acta, 48: 367-80(Dec. 1969). (In French).

The measurement of deviations from stoichiometry x of uranium dioxide UO_{2+x} was investigated in the particular case of x less than 0.01. The powdered sample is dissolved in concentrated phosphoric acid. Uranium(VI) is measured by coulometric reduction at controlled potential; uranium(IV) is oxidized by a standard solution of potassium dichromate. It is shown that the uncertainty in x is essentially due to the lack of reproducibility of the initial dissolution. With the described operating method, values of x equal to 0.0005 were determined with a relative reproducibility of 20%. (auth)

2117 SPECTROPHOTOMETRIC DETERMINATION OF CERIUM WITH METHYLENE BLUE. Vernon, F. (Sheffield Polytechnic, Eng.). Anal. Chim. Acta, 48: 425-7(Dec. 1969).

An investigation with a tracer, ^{141}Ce, showed that under no conditions of pH or concentrations of reagents could cerium be extracted into benzene. In the presence of Ce^{4+}, however, the benzene layer assumes a red color with maximum absorbance at 510 nm, the intensity of which is proportional to the cerium present. The mechanism of the reaction was studied in an attempt to furnish an explanation and also to extend the scope to the determination of Ce^{3+}. Bromate was chosen to oxidize the Ce^{3+}. Microgram quantities of cerium can be determined by this method with an accuracy of ±2.5%. (M.C.G.)

2118 RAPID POLAROGRAPHY OF URANIUM IN 1 M HYDROFLUORIC ACID WITH A VERTICAL-ORIFICE POLYTETRAFLUOROETHYLENE DROPPING-MERCURY ELECTRODE. Raaen, H. P. (Oak Ridge National Lab., Tenn.). Anal. Chim. Acta, 48: 427-30(Dec. 1969).

With the vertical-orifice dropping mercury electrode of Teflon, the polarographic characteristics of uranium in 1M HF were studied. The existence of two waves was indicated, the wave at the more positive potential being very much larger than the other. (M.C.G.)

2119 ATOMIC ABSORPTION DETERMINATION OF MICROGRAM QUANTITIES OF MOLYBDENUM IN LAKE WATERS. Chau, Y. K.; Lum-Shue-Chan, K. (Canada Centre for Inland Waters, Burlington, Ont.). Anal. Chim. Acta, 48: 205-12(Dec. 1969).

The extraction of molybdenum by various complexing agents was studied and their atomic absorption sensitivity compared. Oxine and dithiol are among the most sensitive. Optimum conditions for extraction of molybdenum with oxine at microgram levels and the interference of certain elements in atomic absorption were investi-

gated. Molybdenum was extracted directly from 100 ml of water by oxine in MIBK and determined by atomic absorption spectroscopy with a nitrous oxide-acetylene flame. The coefficient of variation for spiked lake water and natural lake water containing 20 μg Mo/l and 5.56 μg Mo/l were found to be 1.8% and 4.0% respectively. The sensitivity of the method was 1 ppB. (auth)

2120 USE OF CHEMICAL ANALYSIS IN BURN-UP DETERMINATIONS. Regnaud, F. Bull. Inform. Sci. Tech. (Paris), No. 140, 45-51(Sept. 1969). (In French).

The use of chemical and isotopic analysis for burn-up determinations involves the measurement of fissile element depletion or the determination of an element produced by fission. Samples of irradiated fuel are processed according to their plutonium content in the shielded units Armor or Armor II. The isotopic analyses are then carried out by mass spectrometry after separation of any troublesome elements which may be present. (auth)

2121 PERMANENT TESTING OF ISOTOPIC CONCENTRATIONS AT THE PIERRELATTE PLANT. Boyer, R. Bull. Inform. Sci. Tech. (Paris), No. 140, 5-11(Sept. 1969). (In French).

Isotopic concentrations at the Pierrelatte plant are checked by computers. By the use of perforated cards the operating of 17-mass spectrometers can be programmed from 3 centralizing units, which also print the results obtained in the decimal system. The only manual operations involved are the setting up of the sample holders and the preparation and introduction of the perforated cards. An independent central computer makes any necessary corrections to the results supplied by the centralizing units. For an additional investment of 2.5% to the price of the analytical material, automation has led to a saving of 50% on personnel and 100% on the analysis potential. (auth)

2122 ROUTINE TESTS AT THE LA HAGUE UP2 PLANT. Patigny, P.; Levos, Ch. Bull. Inform. Sci. Tech. (Paris), No. 140, 13-22(Sept. 1969). (In French).

Tests are performed continuously by 18 analysts distributed among different laboratories throughout the plant. Sample-taking benches are linked up with 300 points in the plant where samples are taken by analysts. The use of the germanium–lithium diode in γ spectrometry makes possible the analysis of fission products without chemical separation. The plutonium content is obtained by combined α spectrometry and mass spectrometry measurements. (auth)

2123 CONTINUOUS TESTING IN THE MARCOULE PLANT. Chabert, J.; Fontaine, A. Bull. Inform. Sci. Tech. (Paris), No. 140, 23-6(Sept. 1969). (In French).

Considerable improvements, which lead to substantial savings in personnel and sampling material have been made at the Marcoule plant in continuous testing systems. They provide for continuous response, short response time, and representative sampling. These systems include conventional measurements of level, temperature, density, flow-rate, and pH. Other devices measure acidity, plutonium concentration, fission product activity, and neutron doses. These continuous tests do not always provide absolute measurements, but by showing relative variations they often provide immediate detection of an overall plutonium build-up, an irregularity in the process, or an abnormal activity. (auth)

2124 AUTOMATION IN CONTINUOUS ROUTINE ANALYSES: PRESENT SITUATION WITH REGARD TO RESEARCH ON SPECTROPHOTOMETRIC APPLICATIONS. Perez, J. J.; Arbogast, M. Bull. Inform. Sci. Tech. (Paris), No. 140, 27-35(Sept. 1969). (In French).

Problems connected with the automation of chemical analyses in continuous testing laboratories are examined, working from the concept of a multiple-application analysis line. In the case of the spectrocolorimetric method, this line includes: an automatic sample-shopping system, a photometric measurement head, and a data treatment system. The performance of these lines is described in connection with analysis for uranium (IV) and (VI), iron, and phosphates. (auth)

2125 STATISTICAL TREATMENT OF ANALYTICAL RESULTS IN A CONTROL LABORATORY. Neuilly, M. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 140, 37-43(Sept. 1969). (In French).

The determination of impurities and additive elements in uranium alloys, carried out simultaneously by 4 plant laboratories and a central control laboratory, is discussed. Results obtained by the 5 laboratories are treated statistically by means of an IBM 360 computer and perforated cards, after which different graphs are plotted. The quality of the product is verified by the concentration histograms for each element and each laboratory. Divergences between results obtained by different methods or in different laboratories are expressed in averages and variances. It is possible therefore for example to detect certain systematic errors. (auth)

2126 "ATOMIC ABSORPTION SPECTROMETRY" RECENT DEVELOPMENTS. Baudin, G. (CEN, Saclay, France); Pichotin, B.; Spitz, J. Bull. Inform. Sci. Tech. (Paris), No. 140, 53-9(Sept. 1969). (In French).

Recent research includes tests on various types of flames and improvements in the atomization technique. Ultrasonic atomization increases the sensitivity of the method by a factor of 10 with respect to the conventional pneumatic method. For the analysis of radioactive solutions a special study of the apparatus was necessary to avoid the risk of explosion, evacuate heat, and filter the burned gases, leaving only the burner in the glove box. Flameless systems are being studied in a shielded compartment. The analysis can be performed with or without plutonium separation. Although for each operation it is generally possible to measure only one element and only in solution, the method is highly promising since it is one of the most sensitive known to chemistry. (auth)

2127 DETERMINATION OF OXIDE INCLUSION IN COPPER-BASE ALLOYS. II. DETERMINATION OF ZIRCONIUM OXIDE INCLUSION IN Cu–Zr ALLOY. Tsukahara, Iwao; Yamamoto, Toshimi; Tonomura, Takashi. Bunseki Kagaku, 18: 1236-40(Oct. 1969). (In Japanese).

A methanolic bromine method for determination of zirconium oxide inclusion in Cu–Zr alloy has been presented. In order to decide the optimum condition for extracting the inclusion, the effects of decomposition temperature, concentration of bromine, etc., on the solubility (recovery) of zirconium oxide were studied by the use of pure zirconium oxide and internally oxidized Cu–Zr alloy. The zirconium oxide inclusion was isolated completely as the residue from the matrix by this method. The recommended procedure is as follows: 2 ~ 5 g of Cu–Zr alloy is decomposed with methanolic bromine filtered by suction through Membrane filter (UCF, mittel), the residue washed with methanol, ignited in a platinum crucible, and dissolved in a mixture of $HClO_4$, HNO_3, and HF. The solution is evaporated to fumes of $HClO_4$ and made up to 100 ml conc. HNO_3 and water. An aliquot containing 5 to 25 μg of zirconium is taken and HNO_3, urea, and Arsenazo-III are added. The absorbance of 665 mμ is measured against water. The amount of zirconium is determined from its calibration curve. (auth)

2128 DETERMINATION OF MICRO AMOUNT OF CALCIUM IN TANTALUM BY FLAME PHOTOMETRY. Hirano, Shizo; Tofuku, Yoshinobu; Morikawa, Takashi (Toyo Univ., Kawagoe, Japan). Bunseki Kagaku, 18: 1270-2(Oct. 1969). (In Japanese).

A method for the flame photometric determination of calcium in tantalum is presented using a quartz boat, covered by graphite powder and placed in a Pyrex combustion tube. The temperature was raised gradually to about 430°C in a stream of hydrogen chloride (150 ml/min) and matrix tantalum was sublimed off as tantalum chloride. The residue was taken up with hydrochloric acid and filtered. The filtrate was concentrated by evaporation, transferred to a 10 ml volumetric flask and diluted to the mark with water. Two 10 ml aliquots of this solution were transferred to a couple of 10 ml volumetric flasks, to which were then added 1 ml of lanthanum chloride solution (10 mg/ml) and 4 ml of ethanol. A definite volume of standard calcium solution was added to one of the flasks, and calcium was determined flame-photometrically with oxyhydrogen flame and at wavelength 422.7 mμ by standard addition method. (auth)

2129 POTENTIOMETRIC DETERMINATION OF PLUTONIUM IN NITRIC ACID MEDIUM. Emura, Satoru; Okazaki, Shuji (Japan Atomic Energy Research Inst., Tokai). Bunseki Kagaku, 18: 1264-5(Oct. 1969). (In Japanese).

An accurate method is described for the determination of plutonium in nitric acid solutions. In this method, plutonium is directly reduced with titanous chloride solution in a mixture of nitric acid, sulfuric acid, and sulfamic acid, and then titrated with a standard solution of ceric sulfate. The titration curve is recorded by an automatic recording titrator with a combined electrode of platinum with silver–silver chloride. Over the range from 5 to 15 mg of plutonium, the coefficient of variation was 0.5 to 0.25% for the accountability analysis of plutonium in the reprocessing of irradiated fuel. (auth)

2130 STUDIES ON EDTA TITRATION OF MIXED METAL IONS BY RECORDING TITRATION APPARATUS. III. CHELATOMETRIC TITRATION OF MERCURY, CERIUM, OR THORIUM BY POTENTIOMETRIC METHOD. Takahashi, Takeo (Meiji Univ., Tokyo). Bunseki Kagaku, 18: 1255-7(Oct. 1969). (In Japanese).

Each of the metal ions in mixtures of mercury, cerium, or thorium and other heavy metals were examined by potentiometric titration in many kinds of buffer solutions using the recording titration apparatus that describes the titration curve automatically for the indication of the end point. The suitable kinds of buffers were disclosed for EDTA titration of Hg^{2+}, Ce^{3+}, Ce^{4+} or Th^{4+} in mixtures with other heavy metal ions. (auth)

2131 ISOTOPIC MASS SPECTROMETRY OF THE ACTINIDES. Cameron, A. E. (Oak Ridge National Lab., Tenn.). Actinides Rev.; 1: 299-310(Sept 1969).

A double magnetic deflection mass spectrometer with ion counting was used for the routine determination of the isotopic composition of the actinides. Samples of the elements, amounting to only a few nanograms, are plated on small diameter tungsten or platinum wires. A short piece of the wire is crimped in a V filament of rhenium. The temperature ranges for the production of thermal ions from the single filaments are given for the elements. No significant differences in ionization efficiency between elements were observed. (auth)

2132 DETERMINATION OF DEUTERATION LEVELS IN ORGANIC MOLECULES BY NUCLEAR MAGNETIC RESONANCE. Martin, Gerard J.; Quemeneur, Marie-Theresa; Martin, Maryvonne L. (Faculte des Sciences, Nantes, France). Organ. Magnet. Resonance, 1: 191-202(June 1969). (In French).

The accuracy of several methods for D content determination in organic molecules is established. The sample substitution method, where one or two NMR tubes are used, and the internal standard method, either intermolecular or intramolecular, are discussed and compared. Sample substitution methods have the same precision (3.5 to 7%); it is easier to use 2 tubes than 1. Internal standard methods have a precision of 1 to 3%. Typical organic molecules are chosen as examples and results for deuteration levels are calculated according to the methods reviewed; the intermolecular internal standard results are compared with mass spectrometric results; good precision of the internal standard method is thereby confirmed. (BBB)

2133 MICRO-DETERMINATION OF CERIUM. Penzes, I.; Csanyi, L. J. (Attila Jozsef Univ., Szeged, Hungary). Acta Phys. Chem., 15: 55-7(1969).

The determination of Ce(IV) in the absence of Ce(III) is carried out by adjusting the acid concentration to 0.4M H_2SO_4 and measuring the absorbance at 320 nm. The Lambert-Beer law holds in the range of 10^{-5} to 10^{-4}M and the concentration of Ce(IV) can be calculated by using a value of 5540 l/mole cm for the extinction coefficient. When the solution to be analyzed contains Ce(III) ions also, other ways can be used to determine Ce(IV) ions. To this end a series of dyes were tested. For a determination based on the bleaching effect of Ce(IV), the Cu(II) phthalocyanine complex and methylene blue were found to be useful. The Cu(II) complex is readily soluble in water, the blue solution absorbs the light at 620 nm, and its extinction coefficient is as high as 42,000 liter/mole cm. The complex reacts with Ce(IV) ions rapidly. The reaction between methylene blue and Ce(IV) ions may also be used for analytical purposes. In 1M sulfuric acid, ethylene blue has a high absorption peak at 755 nm (the extinction coefficient is 52,600 l/mole cm) and the Lambert-Beer law holds. The interference of Ce(III) can also be avoided by reducing Ce(IV) ions with Fe(II) and measuring the light absorption of the Fe(III) formed (at 304 nm). (BBB)

Isotopic Procedures

2134 DETERMINATION OF THE ISOTOPIC CONCENTRATION OF URANIUM AND PLUTONIUM. Koch, L. (Europaeisches Institut fuer Transurane, Karlsruhe, Ger.). Radiochim. Acta, 12: 160-2(Oct. 1969). (In German).

The simultaneous determination of isotopic concentrations of uranium and plutonium by mass spectrometric isotope dilution analysis is described. The selective behavior of the nitrato complexes on an anion exchanger is used to obtain a uranium and plutonium solution of equal quantities. The difference on ionization efficiency of the two elements makes it possible to determine by mass spectrometry ^{238}Pu in the presence of ^{235}U. (auth)

2135 SUBSTOICHIOMETRY IN ISOTOPE DILUTION ANALYSIS: AUTOMATION OF THE PROCESS WITH REFERENCE TO MERCURY. Cooksey, B. G. Birmingham, Eng., Univ. of Aston, 1969.

Thesis.

Substoichiometry is a radiochemical technique that greatly improves the sensitivity of trace metal analysis by solvent extraction procedures. The basis of the technique is the use of a smaller amount of reagent than the stoichiometric amount required by the metal. In this way the same amount of metal is always extracted. This is convenient in isotope dilution analysis because the activity of the organic phase is then proportional to the specific activity. There is no need to measure the amount of metal actually extracted and a reagent can be used at a low concentration which cannot be measured by conventional techniques. A method of determining mercury by substoichiometric solvent extraction, previously described by Rusioka and Stary, was automated and its limitations investigated and compared with those of the manual method. During the course of this investigation, chloride was found to interfere by forming a ternary complex, mercuric chloride dithizonate. The reactions and properties of this substance were studied and its stability constant determined. Several methods of overcoming this chloride interference were examined. While exploring one of these methods, the addition of ethylenediaminetetraacetic acid, another ternary complex, mercuric chloride ethylenediaminetetraacetate, was recognized and its stability constants were also measured. (UK)

Radiometric Procedures

Refer also to abstracts 2269, 2308, 2439, and 2523.

2136 (NYO-4039-1, pp 74-8) IN VIVO ESTIMATION OF BONE MINERAL CONTENT. Wentworth, R. A.; Kalifelz, F. A.; Corradino, R. A.; Hiltz, F. L. (New York State Veterinary Coll., Ithaca).

A technique for in vivo measurement of bone mineral content was developed. The method is based upon photon-beam-transmission measurements similar to the technique described by Sorenson et al. (Journal of Bone and Joint Surgery, 49A: 481(1967)). Several modifications were employed that make the system versatile for many species of animals and enables rapid availability of results, even while a person or animal is in a scanning position. (auth)

2137 NOTE ON THE APPLICATION OF GAMMA SPECTROMETRY IN SITU TO THE STUDY OF SOLID DISCHARGE IN THE ESTUARY OF THE GIRONDE. Chesselet, Roger (Centre des Faibles Radioactivites, Gif-sur-Yvette, France); Martin, Jean-Marie. Rev. Geogr. Phys. Geol. Dyn., 11: 123-6(Jan.-Mar. 1969). (In French).

A study of the natural radioactivity of sediments and large river waters suggested the use of natural radioactive elements as tracers for transport and sedimentation phenomena of particles in suspension; the method of analysis of radionuclides in seawater is γ spectrometry. Laboratory studies indicated that this method allows the direct measurement of the weight of matter in suspension in river waters. An initial series of measurements carried out in the Gironde estuary in 1966 was based on analysis of ThC'', RaC, ^{137}Cs, ^{137m}Ba, $MsTh_2$, ^{40}K, and ThC. Contributions were fairly constant: about 1.6 pCi for ^{226}Ra, 1.0 pCi for ^{232}Th, and 0.3 pCi for ^{137}Cs. A study of the variation in turbidity by γ spectrometry was also carried out. Rapid analysis of seawater flow in the estuary may be made by monitoring the counting level of the peak of ^{40}K at 1.46 MeV. (BBB)

2138 COMPARISON OF RADIOTRACER AND ELECTROCHEMICAL METHODS FOR THE MEASUREMENT OF THE ELECTROSORPTION OF ORGANIC MOLECULES. Gileadi, E.; Duic, L.; Bockris, J. O'M. (Tel-Aviv Univ., Israel. Univ. of Pennsylvania, Philadelphia). Electrochim. Acta, 13: 1915-35 (Sept. 1968).

The electrosorption of benzene on platinized Pt was reinvestigated by a radiotracer (carbon-14) and three electrochemical methods. The results obtained by all four techniques are in good agreement in certain potential and temperature ranges. At higher positive potentials agreement between the three electrochemical methods is found but the radiotracer method yields higher coverage values. The discrepancy is attributed to the existence on the surface, in such potential ranges, of significant concentrations of intermediate radicals formed during the oxidation of benzene to CO_2. The significance and reliability of results obtained by the various techniques for adsorption measurements show the necessity always to employ both radiotracer and electrochemical methods to the same system. From an analysis of the potential dependence of the total number of radioactive particles on the surface, and the apparent coverage (using the number of electrons which are assumed for the over-all reaction) given by the electrochemical methods, information concerning radicals present on the surface may be gained. The shape of the coverage/potential relation gives information as to the general nature of the species that predominate on the electrode surface. If radicals involved in the reaction predominate, the θ/V relation is unlikely to be parabolic: the observation of such a relation thus indicates the predominance of

adsorbed solute. If there is good agreement between electrochemical and radioactive methods, this is confirmed. Use of both radiotracer and electrochemical techniques together for studying adsorption is particularly informative. The study of adsorption isotherms as a basis to electrode-kinetics-mechanism determination is important. (auth) (UK)

2139 A METHOD FOR THE QUANTITATIVE DETERMINATION OF TRITIUM ON METAL SURFACES. Bindewald, Hilmar; Knaelmann, Marita (Technical Univ., Hanover). Atomkernenergie, 14: 431-4(Nov.-Dec. 1969).

In the procedure described, tritium on metal surfaces is quantitatively measured by cutting out small samples from metal surfaces and bringing the tritium into solution by combustion. The activity of the solution is measured with a liquid scintillation counter. This procedure, is, to a large degree, independent of a possible radioactivity and type of the carrier material. (auth)

2140 ION EXCHANGE, EXTRACTION, SEPARATION, AND RADIOCHEMICAL DETERMINATION OF ^{237}Ne IN ^{238}Pu. Bubernak, J.; Lew, M. S.; Matlack, G. M. (Los Alamos Scientific Lab., N. Mex.). Anal. Chim. Acta, 48: 233-241(Dec. 1969).

Neptunium-237 in concentrations of 10 ppM can be isolated from 10-mg quantities of ^{238}Pu with sufficient purity to allow its determination by direct α counting. After suitable treatment of the sample in hydrobromic acid, neptunium(V) is separated from the bulk of plutonium by cation exchange. The neptunium eluate is then treated with tin(II) chloride, and neptunium(IV) is extracted into TTA–xylene, leaving the last amount of plutonium in the aqueous phase. Uranium causes no problem and can be determined simultaneously in the same sample. (auth)

2141 USE OF COMMERCIALLY AVAILABLE NONIONIC SURFACTANTS AS EMULSIFYING AGENTS IN LIQUID SCINTILLATION COUNTING FOR AQUEOUS SAMPLES OF LOW LEVEL TRITIUM. Iwakura, Tetsuo; Maebayashi, Aiko; Kasida, Yoshiko (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 18: 506-9(Nov. 1969).

Liponox NCJ and Lion Triton were found to be suitable surfactants for the low-temperature counting and the NCJ system shows the highest figure of merit, 152.6, which corresponds to the counting sensitivity of 91.0 T.U./cpm for a low-level tritium sample. For room temperature counting, Liponox NCK and Triton-X 100 of Rohm & Haas are equal in superiority to the other surfactants. The ratio of the efficiency utilizing external standard ratios to the efficiency obtained from internal standard activities can be used as an index of the phase separation state of the sample which varies from 1 to 2. The use of a polyethylene vial is recommended for routine low-level counting. (auth)

2142 MEASUREMENT OF BETA ACTIVITIES IN AQUEOUS SOLUTION UTILIZING CHERENKOV EFFECT BY MEANS OF LIQUID SCINTILLATION COUNTERS. Iwakura, Tetsuo (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 18: 500-5(Nov. 1969).

Cherenkov counting using commercially available liquid scintillation counters provides a useful method for the radioassay of energetic beta-emitting radionuclides of above 500 keV. Advantages over liquid scintillation counting are the easy sample preparation, which does not require complicated chemical procedures and the reasonable cost of the scintillator. Moreover any transparent liquid can be used as a medium without chemical quenching. The method is very useful for rapid and direct measurement in the field of radioactivity surveillance. (auth)

2143 SIMULTANEOUS DETERMINATION OF THE ISOTOPE RATIO ^{234}U/^{238}U AND OF THE ^{238}U CONTENT OF NATURAL WATERS. Nguyen Huu, Van; Lalou, Claude (CNRS, Gif-sur-Yvette, France. CEN de Saclay, Gif-sur-Yvette, France). Radiochim. Acta, 12: 156-60(Oct. 1969). (In French).

A precise and relatively rapid method of determination of the activity ratio of ^{234}U/^{238}U and of the ^{238}U content in various types of natural waters was worked out. Uranium is first concentrated on activated charcoal. The separation between uranium and iron is done on anion exchange resin (Dowex 1 X 8–200/400) in HCl 6$\underline{N}$ + $HClO_4$ 1$\underline{N}$ medium. After, the uranium is purified and electrolytically deposited. ^{232}U is used as a tracer. The measurement of activity of uranium is made by a semi-conductor α spectrometer. The resolution is 70 to 120 keV (F.W.H.M.) for the three energies corresponding to the main alpha rays of ^{238}U, ^{234}U and ^{232}U. (auth)

2144 THE USE OF 1,2-CYCLOHEPTANEDIONE-DIOXIME (HEPTOXIME) IN THE DETERMINATION OF NICKEL RADIONUCLIDES. Beasley, T. M. (Univ. of Washington, Seattle). Health Phys., 17: 743-5(Nov. 1969).

A procedure using heptoxime as a reagent was adapted for use in the radiochemical determination of ^{63}Ni in the environmental samples. Decontamination of nickel from other radionuclides was excellent. The method is not a rapid one, requiring a working time of two hours when samples are analyzed in groups of six. Bone samples weighing 10g (wet weight) and tissue samples weighing 20g (dry weight) are easily analyzed. The method is not only useful in the analysis of biota, but should be equally applicable to the analysis of large volumes (1 gallon) of reactor effluent and to cosmogenic material containing ^{59}Ni. There are two disadvantages; first, bone samples greater than 10g are difficult to analyze. Second, the cost of the heptoxime is high ($6.00/g). In spite of these, its use in isolating radionuclides of nickel from complex radioisotope mixtures is effective. (UK)

2145 SULPHUR DETERMINATION IN ORGANIC COMPOUNDS BY RADIOREAGENT METHOD. Mlinko, S.; Dobis, E. (Central Research Inst. for Chemistry, Budapest). Acta Chim. Acad. Sci. Hung., 61: 133-48(1969).

A procedure and an apparatus are described for the radiometric determination of the sulfur content of organic compounds. The sulfur content of organic compounds is converted by destructive hydrogenation to hydrogen sulfide and the hydrogen sulfide conducted with hydrogen carrier gas through a $Cd^{14}CO_3$ filling. From the cadmium carbonate and hydrogen sulfide cadmium sulfide, water and carbon dioxide are formed at room temperature in the presence of water. The activity of carbon dioxide formed in the course of the reaction was measured according to the ^{14}C analyses with methane counting gas in the proportional region. For the elaboration of the procedure oxide-hydrate-free cadmium carbonate was synthesized. The thermal properties of the radioactive reagent were studied in air- and hydrogen-atmosphere. According to the assumed adsorptive ion exchange an explanation of the reaction was given. The conditions of the basic reaction taking place quantitatively were examined during the formation of the sulfide content. The restricted efficiency of the cadmium carbonate, derived from the experimental data, was accounted for by the formation of the solid solutions of cadmium carbonate and cadmium sulfide and with the restricted mixed crystal formation. (auth)

2146 DETERMINATION OF ^{239}Pu BY FISSION TRACKS. Yabuki, Hideo; Shima, Makoto (Inst. of Physical and Chemical Research, Yamato, Japan). Bunseki Kagaku, 18: 1265-7(Oct. 1969). (In Japanese).

The determination of ^{239}Pu is examined by the technique of fission track method that has been used frequently for the microanalysis on uranium. The results are very consistent with expected value from the calculation, and it is revealed that fission track method can be applied conveniently for semiquantitative determination of plutonium distribution. (auth)

2147 ANALYTICAL METHODS BASED ON REFLECTION AND ABSORPTION OF RADIOACTIVE RADIATION. VIII. THE USE OF THE BETA BACK DISPERSION FOR THE EVALUATION OF STABILITY OF EMULSIONS OF THE o/w TYPE. Jombik, J.; Gruntova, Z.; Schiller, P. (Comenius Univ., Bratislavia). Cesk. Farm., 17: 419-22(Nov. 1968). (In Czech).

A radiometric method, which measures the intensity of back dispersion of the beta radiation, was used for the evaluation of stability of o/w emulsion systems. The fact that the principal components of these systems are water and oil differing in average rank numbers and specific gravity was taken into consideration. At damaged stability, the oil particles migrate, owing to their specific gravity, to the upper parts of the measured system and its average rank number is altered. A larger amount of sample is used for measurement; its quantity must exceed the saturated layer. The radiometric method is easier than microscopic examination and indicates the instability of emulsions sensitivity. (auth)

Activation Procedures

Refer also to abstract 2536.

2148 (COO-912-16) ACTIVATION ANALYSIS IDENTIFICATION OF THE GEOLOGIC ORIGINS OF PREHISTORIC OBSIDIAN ARTIFACTS. Gordus, Adon A.; Griffin, James B.; Wright, Gary A. (Michigan Univ., Ann Arbor). Dec. 1968. Contract AT(11-1)-912. 39p. Dep. CFSTI.

The elemental composition of obsidian samples was determined using neutron activation analysis. The geologic origins of prehistoric obsidian artifacts were identified by matching the Na, Mn, La, Sm, Sc, Fe, and Rb contents of the artifacts with that of obsidian from geologic sources. Discussed here are studies of obsidian recovered from the 2000-year-old Hopewell sites in the Midwestern United States and from archaeological sites in the Near East that date to the period 7500 to 3500 B.C. (auth)

2149 (IEA-176) STUDY OF THE INFLUENCE OF VARIOUS FACTORS ON THE RADIOCHEMICAL: GUTZEIT METHOD OF ACTIVATION ANALYSIS OF ARSENIC. Lima, Fausto W.; Silva, Celia M. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Nov. 1968. 20p. (CONF-680423-3). Dep. CFSTI (U. S. Sales Only).

From 2nd Inter-American Conference on Radiochemistry, Mexico City, Mex.

Various factors that might influence recovery of arsenic in the radio-chemical-Gutzeit method of determination of arsenic were studied. The factors examined were method of digestion of samples, time of reaction, amount of iron ions, amount of stannous ions, interference caused by the presence of antimony and copper, effect of agitation of reaction flasks on abbreviating the time of reaction and amount of arsenic carrier required for a high recovery of arsenic. Precision and accuracy of the proposed method were determined. (auth)

2150 (SC-RR-69-568) CHARACTERIZATION OF MATERIALS BY QUALITATIVE NEUTRON ACTIVATION ANALYSIS. Kenna, B. T.; Harrison, P. E. (Sandia Labs., Albuquerque, N. Mex.). Nov 1969. 12p. Dep. CFSTI.

The use of qualitative neutron activation analysis, which includes gamma spectrometry, is shown to be feasible for characterization of polyethylene and aluminum alloy systems. These two diverse matrix systems were chosen to demonstrate the generality of the approach. The gamma spectrum arising from the radioelements produced can be unique since particular elements are present in a sample in specific quantities. The full utilization of the method can be realized when various factors concerning the production and counting of the radionuclides are maximized. In addition, comparison of photopeak intensity ratios increases the usefulness of the method. (auth)

2151 (SRRC-30/69) AN ASSESSMENT OF THE PROBABLE ERRORS IN DETERMINING CALCIUM IN SECTIONS OF BONE BY IN VIVO ACTIVATION ANALYSIS. Boddy, Keith; Al-Hashimi, S. A. M.; Boyle, I. T. (Scottish Research Reactor Centre, East Kilbride (Scotland)). Dec. 1968. 8p. Dep. CFSTI (U. S. Sales Only).

The reproducibility of in vitro irradiation of phantoms and sections of bone under conditions similar to those that will be used for in vivo calcium determinations was investigated. Preliminary estimates of errors associated with the process were obtained. (M.C.G.)

2152 (UCRL-18981) RADIOACTIVATION BY ^{3}He BOMBARDMENT: A PRACTICAL ANALYTICAL SYSTEM. Lamb, James Francis (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1969. Contract W-7405-eng-48. 230p. Dep. CFSTI.

Thesis.

Charged-particle activation analysis using 1- to 30-MeV ^{3}He ions as the nuclear reaction inducing particle is discussed from a practical point of view with emphasis on the light elements, especially oxygen. Definitions and expressions fundamental to charged-particle activation analysis are given with brief discussions. Also included are convenient ^{3}He activation analysis reference curves for estimating Coulomb barriers and the effects of Rutherford scattering on the incident beam. Range-energy tables for ^{3}He ions in nongaseous targets of the stable isotopes of all elements and an extensive Q-value table for the more important ^{3}He-induced reactions appear as appendices. A summary of excitation functions and reaction data for ^{3}He-induced reactions in Be, B, C, N, O, F, Na, Mg, Al, Si, Ca, Ti, Fe, Ni, Cu, Ge, Ta, and Au is given; it contains experimental measurements as well as values from the literature. All the excitation functions were redrawn to the same scale to permit convenient comparison. A brief discussion of the recognizable trends in the excitation functions for the more important ^{3}He-induced reactions follows the experimental data. The results of several analyses illustrating special methods and applications of ^{3}He activation analysis are given. These include simultaneous isotopic analysis of ^{16}O and ^{18}O and the preparation of thick Ta_2O_5 oxygen standards, surface depth profile analysis of oxygen in silicon, use of matrix activation as an internal normalization standard in the determination of oxygen in iron and nickel, and the use of Au, Pt, and Ta as target supports and cover foils. The applicability, interference, sensitivity, and unique features of ^{3}He activation analysis are discussed. (auth)

2153 DETERMINATION OF 10 TRACE ELEMENTS IN BIOLOGICAL MATERIALS BY THE METHOD OF NEUTRON ACTIVATION ANALYSIS. Karlicek, V.; Kott, J.; Sova, J.; Bilkova, L.; Topolcan, O. (Charles Univ., Pizen, Czech.). Cas. Lek. Cesk., 108: 1017-21(Aug. 8, 1969). (In Czech).

Determination of Co, Fe, Sb, Zn, Au, Cd, Ca, Rb, Cu, and Cs in the blood, heart muscle, and in the kidneys by neutron activation analysis is described. The elements were separated by group separation on ion exchangers. All of the elements can be determined with satisfactory accuracy without using carriers. (JPRS)

2154 DETERMINATION OF SAMARIUM IN ROCKS BY EPITHERMAL NEUTRON-ACTIVATION ANALYSIS. Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Z. Anal. Chem., 247: 23-7(Oct. 15, 1969).

A nondestructive neutron activation method for the determination of samarium in rocks, based on activation with epithermal neutrons, is described. By this means the formation of ^{153}Sm, as compared to most interfering radionuclides, is considerably higher than by thermal neutron activation. The precision of the method is 2 to 3% in the range of 3 to 25 ppM and the sensivity is about 0.1 ppM. Results are presented for some standard rocks. The influence of other rare earth nuclides on the measurement of the 41-keV x-ray of ^{153}Sm was investigated. (auth)

2155 ACTIVATION ANALYSIS OF SMALL QUANTITIES OF TELLURIUM, CHLORINE, THALLIUM, AND NICKEL IN SELENIUM. Neeb, K. H.; Martin, J.; Franke, R. (Siemens A. G., Erlangen, Ger.). Z. Anal. Chem., 247: 27-31(Oct. 15, 1969). (In German).

Neutron activation analysis was used for determining the Te, Cl, Tl, and Ni doping materials in small samples of selenium weighing between 1 and 10 mg. The impurity activities can be isolated from the ^{75}Se matrix activity by means of distillation, extraction, and precipitation. The scheme of analysis described permits the determination of the elements present in each sample in quantities between 0.05 and 0.5 μg with an accuracy of 5%. (auth)

2156 SIMPLIFIED PRECISION SYSTEM FOR OXYGEN ANALYSIS BY FAST NEUTRON ACTIVATION. Karttunen, E. (Univ. of Helsinki); Gardner, D. G. Int. J. Appl. Radiat. Isotop., 20: 801-5(Nov. 1969).

It is stated that by using an external standard in the form of a lucite sleeve surrounding the sample capsule it appears possible to reduce or avoid not only errors arising from fluctuations in the neutron flux but also timing errors in the irradiation, transfer, and counting of solid samples undergoing activation analysis for oxygen content. Even if the sample is placed in a region of high flux gradient the effects of changes in irradiation geometry and focusing of the ion beam striking the tritium target are greatly reduced as compared with systems where the standard and sample are irradiated separately or where some kind of external neutron counter is used to integrate the flux. Furthermore, the effects of neutron flux depression are practically eliminated by the positioning of the standard as a sleeve around the sample capsule. Only a single measurement of the geometry factor is thus required to cover a wide range of sample densities and scattering cross sections. For samples having an oxygen content exceeding several milligrams an absolute systematic error of less than about 2% might be expected, and for samples containing <0.02% oxygen by weight an error of about 0.001% might be expected. The method could be used for other analyses where a suitable material for the sleeve can be found. Plastic sleeves containing dispersions of a standard material might be appropriate. Data are given for a wide variety of materials, including a variety of steels. (UK)

2157 CHROMIUM SEPARATION BY INORGANIC EXCHANGERS IN ACTIVATION ANALYSIS OF BIOLOGICAL MATERIALS. Meloni, Sandro; Brandone, Alberto; Maxia, Vera (Univ., Pavia, Italy). Int. J. Appl. Radiat. Isotop., 20: 757-60 (Nov. 1969).

A neutron activation technique for determining chromium in blood serum and red cells is described. Carrier-free chromium-51 is adsorbed onto manganese dioxide, after removal of sodium-24 and phosphorus-32 by adsorption onto hydrated antimony(V) oxide and tim(IV) oxide, respectively. The separation takes 1.5 hr and recovery is 99 percent. 0.35 to 0.23 μg chromium were found per milliliter of serum or red cells. (auth) (UK)

2158 ANALYZING ELEMENTS WITH NEUTRON ACTIVATION. Sandquist, G. M. (Univ. of Utah, Salt Lake City); Matsuura, S. T. Eng. Mining J., 170: No. 10, 87-9(Oct. 1969).

Procedures and applications of neutron activation analysis are discussed. A table is presented of the absolute detection limits of elements by thermal and fast neutron activation methods. Economic aspects are also considered. (M.C.G.)

2159 SEPARATION AND DETERMINATION BY NEUTRON ACTIVATION OF TRACES OF HAFNIUM IN SCANDIUM. Balsenc, L.; Haerdi, W.; Monnier, D. (Univ., Geneva). Anal. Chim. Acta, 48: 213-8(Dec. 1969). (In French).

A method is proposed for the separation and determination of traces of hafnium (≥1 ppM) in scandium metal. The metals, as sulfate complexes, are separated by anion exchange in sulfuric acid medium. Analysis by thermal neutron activation is based on the formation of ^{179m}Hf ($T_{\frac{1}{2}}$ = 19 sec) and ^{46m}Sc ($T_{\frac{1}{2}}$ = 19.5 sec). The complete separation and determination require only 1 h. (auth)

2160 DETERMINATION OF IMPURITIES IN ZINC BY NEUTRON ACTIVATION. PART II. THE DETERMINATION OF GERMANIUM. Machiroux, R.; Mousty, F. (Univ., Liege). Anal. Chim. Acta, 48: 219-26(Dec. 1969). (In French).

After separation of germanium and zinc on a Dowex 50 resin at pH 1.42, germanium is precipitated as GeS_2, and the ^{71}Ge x-ray activity is counted by scintillation. The chemical yield is determined by classical polarography. Before zone refining, the germanium concentration in zinc was found to be 0.109 ± 0.024 ppM; after zone refining, the content decreased to 0.049 ± 0.014 ppM. (auth)

2161 NEUTRON ACTIVATION ANALYSIS. Laverlochere, J. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 140, 61-3(Sept. 1969). (In French).

Improvements in neutron activation analysis are due to the use of high neutron fluxes and short-lived radioisotopes, the ease with which the thermal neutron/fast neutron ratio can be varied, the improvement in fast neutron generators, and the automation of equipment, chemical separations, and counting. Studies on the use of germanium–lithium detectors and link-up with computers are under way. The method is used for trace measurements and for the nondestructive determination of higher concentrations. In industry new sources are available for continuous measurements on liquids and powders. (auth)

2162 ANALYSIS BY ACTIVATION IN CHARGED PARTICLES AND γ PHOTONS. Engelmann, Ch. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 140, 65-70(Sept. 1969). (In French).

Many elements can be determined by activation both by charged particles (alpha, deutrons, protons, tritons, etc.) and by gamma photons. The methods are simple, fast, sometimes nondestructive and in certain cases allow the localization of impurities. The methods are particularly useful for the determination of light elements, such as B, C, N, O, F in relative concentrations of 10^{-9}. In addition the fact that the samples can be cleaned to the desired depth after irradiation and before measurement excludes any risk of pollution. These methods are therefore exceptionally useful for the analysis of extremely pure materials. (auth)

2163 CHOICE OF ACTIVABLE TRACER FOR SPRAYING AGRICULTURAL INSECTICIDES BY HELICOPTER. Bando, Shoji; Tominaga, Hiroshi; Kawakami, Yutaka; Senoo, Muneaki (Japan Atomic Energy Research Inst., Ibaraki). Radioisotopes (Tokyo), 18: 488-93(Nov. 1969). (In Japanese).

Fundamental studies were made on the selection of activable tracers, which can be used to examine the distribution of agricultural insecticide sprayed by helicopter. Considering the conditions that the samples are organic substances, sufficiently strong radioactivity should be produced in a short irradiation time, and the half-life of the activity should be longer than two hours for the sake of convenience of activity measurement; therefore, manganese, gold, and europium were selected as typical tracers. Other conditions required for the field experiments were checked on these elements. Minimum detectable limits of each tracer were estimated from both the activity produced by each tracer and the background due to interference components in the sample. As a result, europium tracer was found to be the most sensitive (minimum detectable limit was 1.5×10^{-10} g Eu/5 cm^2 filter paper) and also the lowest in cost, if the sampling was carried out using filter paper and a thin scintillator was used to measure low-energy photons. It was concluded that europium would be the most suitable tracer for the determination of distribution of insecticide sprayed by helicopter. (auth)

2164 DETERMINATION OF TRACE ELEMENTS IN THE REFERENCE CIGARETTE TOBACCO BY NEUTRON ACTIVATION ANALYSIS. Nadkarni, R. A.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Radiochem. Radioanal. Lett., 2: 161-8 (Nov. 20, 1969).

A standard cigarette was manufactured at the University of Kentucky for distribution as a reference cigarette for the work on tobacco and health research. Nondestructive neutron activation analysis was applied to determine the concentrations of twelve trace elements in this material. In a radiochemical procedure, ^{24}Na and ^{42}K were separated on hydrated antimony pentoxide. The elements determined include La, As, Br, Se, Cs, Sb, Cr, Ag, Sc, Zn, Fe, and Co. (auth)

2165 APPLICATIONS OF RARE EARTH TRACERS TO GUNPOWDER RESIDUES. Pillay, K. K. S. (Western New York Nuclear Research Center, Inc., Buffalo); Thomas, C. C. Jr.; Hart, D. M.; Didising, D.; Thomas, R. C. Nucl. Appl. Technol., 8: 73-8(Jan. 1970).

Results of an experimental investigation of a gunpowder residue test based on the addition of 0.1 wt % rare earth oxide to gunpowder are reported. A total of 512 test samples were subjected to statistical analysis. The findings of this investigation demonstrate that the use of europium-labeled gunpowder and neutron activation can provide the basis for a rapid and simple instrumental gunpowder residue test that can detect the firing of a weapon with a high degree of probability. The results of the tests with europium-labeled gunpowder were compared with the analysis of barium and antimony in primer residues. A cost analysis indicates that europium labeling of gunpowder will increase the cost of ammunition by less than two percent. (auth)

2166 NONDESTRUCTIVE ASSAY OF FISSIONABLE MATERIALS. Jones, D. W.; Malmberg, P. R.; May, T. H.; Strain, C. V. (Naval Research Lab., Washington, D. C.). Nucl. Appl. Technol., 8: 79-83(Jan. 1970).

A new technique for assaying uranium samples based upon the difference in the fission cross-sections of uranium isotopes was studied. In a test of this method samples of uranium containing both ^{235}U and ^{238}U were bombarded with a beam of 0.5-MeV neutrons obtained from the $^3H(p,n)^3He$ reaction. The 0.5-MeV neutrons caused the ^{235}U nuclei to fission but failed to activate the ^{238}U because of its high fission threshold. Fission neutrons from ^{235}U were detected by a recoil proton scintillation counter which used the technique of pulse shape discrimination to reject pulses induced in the detector by gamma rays. The relative sensitivities of the apparatus to ^{235}U and ^{238}U were measured and the ability of this method to detect changes in the ^{235}U content of a sample of uranium containing only a few percent of ^{238}U was studied. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 2241, 2243, 2281, 2282, 2289, 2290, 2879, 2924, 2934, 2956, 2957, 2988, and 2997.

2167 (COO-716-51) AN INVESTIGATION OF SOME LANTHANIDE BORON, CARBON, NITROGEN, SILICON, CHALCOGENIDE, AND HALIDE SYSTEMS AT ELEVATED TEMPERATURES. Technical Progress Report, February 1, 1969–January 31, 1970. Eick, Harry A. (Michigan State Univ., East Lansing. Dept. of Chemistry). Contract AT(11-1)-716. 32p. Dep. CFSTI.

Progress is reported on studies of the vaporization behavior of TmC_2; the crystal structure of TmC_2; vaporization behavior and crystal structure of $YbCl_2$, and other features of the Yb–Cl system; thermal decomposition of SmOF; vaporization of EuS; vaporization thermodynamics of $EuBr_3$; and the structure of YbOCl. (D.H.M.)

2168 (JEN-203-DMa/I-23) DISSOLUTION OF ALUMINUM. Uriarte Hueda, A.; Berberana Eizmendi, M.; Pereira Sanchez, G. (Junta de Energia Nuclear, Madrid (Spain). Division de Materiales). 1968. 18p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

The dissolution of aluminum with acid solutions (nitric acid–mercuric nitrate) and alkaline solutions (sodium hydroxide–sodium nitrate) was studied. The instantaneous dissolution rate (1 DR) was studied as a function of the concentration of used reagents and dissolution temperature. The total dissolution time, the consumption of reagents, and the stability of the resultant solutions are discussed. (auth)

2169 (LA-4282) THE SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. XV. LANTHANUM. Brooks, K. C.; Bowersox, D. F. (Los Alamos Scientific Lab., N. Mex.). 25 Aug 1969. Contract W-7405-eng-36. 2p. Dep. CFSTI.

The solubility of lanthanum in liquid plutonium was measured over the range of 700 to 825°C. The solubility, which was measured in CaF_2 crucibles, increased from 0.31 wt % lanthanum at 700°C to 0.95 wt % at 825°C. The temperature range was limited because of the appearance of two immiscible liquids at 850°C. The equation $\log N_{La} = 1.923 - 4.086 \times 10^3\, T^{-1}$, where N_{La} is the solubility expressed as the mole fraction and T is the temperature in

degrees Kelvin, fits the data in the temperature range studied. (auth)

2170 GENERAL BASE CATALYSIS OF THIOSEMICARBAZONE FORMATION. Sayer, Jane M.; Jencks, William P. (Brandeis Univ., Waltham, Mass.). J. Amer. Chem. Soc., 91: 6353-61(Nov. 5, 1969).

Thiosemicarbazone formation from p-chlorobenzaldehyde exhibits a change in rate-determining step at about pH 4, similar to that in semicarbazone formation, with rate-determining amine attack below and rate-determining dehydration above this pH. The attack step is subject to general acid catalysis by carboxylic acids with a Brønsted coefficient $\alpha = 0.15$. It is also subject to base catalysis. The dehydration step provides the first reported example of general base catalysis of this class of reaction. A number of bases of different structure and charge type follow a Brønsted line of slope 0.71. The reverse reaction is formulated as an attack of hydroxide ion on the free imine which is subject to general acid catalysis. The solvent deuterium isotope effects, k_{H_2O}/k_{D_2O}, are 3.2 and 2.6 for catalysis by triethylenediamine and 3-quinuclidinol, respectively, whereas k_{OH^-}/k_{OD^-} is 1.05. The dehydration step is subject to general acid catalysis by phosphate and dimethylmalonate monoanions, as well as by the solvated proton. The isotope effect, K_{H_2O}/K_{D_2O}, on the ionization constants as acids on both thiosemicarbazide ($pK_{aH_2O'} = 12.81$) and p-chlorobenzaldehyde thiosemicarbazone ($pK_{aH_2O'} = 11.20$) is 4.0 ± 0.1. (auth)

2171 ION-EXCHANGE PAPER CHROMATOGRAPHY OF INORGANIC IONS. XXV. SOME CONSIDERATIONS OF THE DETERMINATION OF THE "CHARGE" OF A METAL ION BY ION-EXCHANGE EQUILIBRIA. Cerrai, E.; Ghersini, G.; Lederer, M.; Mazzei, M. (CISE, Milan. CNR, Rome). J. Chromatogr., 44: 161-6(Oct. 14, 1969).

Ion exchangers with few reactive groups such as cellulose sulfonic acid paper do not distinguish between ions of different charges in the law of mass action equation. It is suggested that this is due to the large distance between the exchange groups. Similar results are obtained with papers impregnated with very dilute solutions of liquid ion exchangers. (auth)

2172 SECONDARY ISOTOPE EFFECTS IN REACTIONS CATALYZED BY YEAST AND MUSCLE ALDOLASE. Biellmann, J. F.; O'Connell, E. L.; Rose, Irwin A. (Inst. for Cancer Research, Philadelphia). J. Amer. Chem. Soc., 91: 6484-8(Nov. 5, 1969).

The aldolase-catalyzed condensation of (1R)-[1-^{3}H]dihydroxyacetone-P with D-glyceraldehyde-3-P to give [3-^{3}H]fructose-1,6-diP was found to go more slowly than normal under conditions which previously indicated that the proton abstraction step is rate determining. Furthermore, slower reaction of fructose-diP containing ^{3}H at C-3 or C-4 is characteristic of both the yeast and muscle enzymes, indicating that the C–C cleavage step (kinetic effect) or glyceraldehyde-P release (equilibrium effect) is the rate-limiting step for the formation of the first product, glyceraldehyde-3-P. (auth)

2173 SOLUBILITY OF HELIUM IN LIQUID SODIUM. Thormeier, Klaus (Institut fuer Reaktorentwicklung, Karlsruhe, Ger.). Atomkernenergie, 14: 449(Nov.-Dec. 1969).

The solubility of Ar and He in liquid Na was measured as a function of temperature, gas partial pressure, oxygen and carbon content, and time. No effects from the impurity content in Na over the solubility of inert gases were found. The He solubility was about eight times the Ar solubility. Both solubilities increased with temperature, but the increase of the He curve was less steep than for Ar. The heats of solution calculated from the curves are: $\Delta H_{Ar} = 19.9$ kcal/mole, $\Delta H_{He} = 16.4$ kcal/mole. (P.C.H.)

2174 ELECTRONIC SPECTRA OF THE U^{+3} ION. Jezowska-Trzebiatowska, B.; Drozdzynski, J.; Bukietynska, K. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 17: 295-300 (1969).

The absorption spectra of U^{3+} ion were measured in methanol, glacial acetic acid, and anhydrous formic acid. The measurements in anhydrous media exclude also the appearance of the U^{4+} bands in the U^{3+} spectrum. Extremely complex character of the absorption spectrum of U^{3+} and the present state of theory and measuring techniques make all the considerations on the energy of the levels approximate. Results show that in the case of the very complex spectra, even intermediate coupling scheme was not satisfactory. (D.H.M.)

2175 CRYSTAL STRUCTURE OF KU_2F_9. Brunton, George (Oak Ridge National Lab., Tenn.). Acta Crystallogr., Sect. B, 25: 1919-21(1969).

The compound KU_2F_9 crystallizes with space group Pnma and with lattice constants $a_0 = 8.7021$ (5), $b_0 = 11.4769$ (4) and $c_0 = 7.0350$ (3) Å. The U^{4+} ions are coordinated by $9F^-$ at distances 2.292 (1) to 2.39 (3) Å and the K^+ ions are coordinated by $10F^-$ at distances 2.62 (2) to 3.21 (2) Å. (auth) (Denmark)

2176 DETERMINATION OF THE CRYSTAL STRUCTURE OF CADMIUM NITRATE TETRADEUTERATE BY MEANS OF NEUTRON ANOMALOUS DISPERSION MEASUREMENTS. Macdonald, A. C.; Sikka, S. K. (Atomic Energy Research Establishment, Harwell, Eng.). Acta Crystallogr., Sect. B, 25: 1804-11 (1969).

The method of solving the phase problem by use of neutron anomalous scattering measurements at a single wavelength was tested in the structure determination of $Cd(NO_3)_2 \cdot 4D_2O$. It was shown that the structure can be obtained independently from both the "direct-phase" and the sine Patterson procedures. The structural parameters are refined by the method of least-squares to an R value of 0.074; the refined value of b''_{Cd} is $0.105\ (9) \times 10^{-12}$ cm at a wavelength of 1.054 Å. The hydrogen bonding scheme is elucidated. (auth) (Denmark)

2177 DETERMINATION OF THE CONTRIBUTIONS OF CONCURRENT ACETAL AND VINYL ETHER HYDROLYSES ON THE BASIS OF THE DIFFERENT SOLVENT ISOTOPE EFFECTS IN THESE REACTIONS. Kankaanpera, Alpo (Univ. of Turku, Finland). Acta Chem. Scand., 23: 1465-70(1969).

The deuterium solvent isotope effect in the hydrolysis of 2-ethoxy-2,3-dihydropyran, $k_{D_2O^+}/k_{H_2O^+} = 1.26$, indicates that this reaction involves both a proton transfer mechanism of vinyl ether hydrolysis and an A-1 mechanism of acetal hydrolysis. The apparent activation entropy of the hydrolysis (+7.1 eu) is in agreement with this conclusion. The contributions of both of these reactions were calculated on the basis of rate coefficients in D_2O and in D_2O-H_2O mixtures. The A-1 hydrolysis proceeds via a cyclic carbonium ion in spite of the fact that this ion is energetically unfavored owing to its planar structure; the contribution of the A-1 ring fission is negligible. (auth)

2178 ELECTRONIC STRUCTURE OF AZO COMPOUNDS AND THEIR COMPLEXES WITH ELEMENTS. COMMUNICATION 8. THE STRUCTURE OF THE La^{3+} AND UO_2^{2+} COMPLEXES WITH ARSENAZO III. Kuzin, E. L.; Savvin, S. B. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 24: 1480-9(Oct. 1969). (In Russian).

The peculiarities of the absorption spectra of solutions of the Arsenazo III complexes with La^{3+} and UO_2^{2+} are explained by the existence of two tautomeric forms of the complexes which are at an equilibrium with each other. The π-electron structural characteristics of Arsenazo I, Arsenazo III, and their complexes are considered. It was found that one of the reasons for the interaction of metal ions with Arsenazo III in acid media is the stronger basicity of the azogroup due to the distribution of the π-electrons and the stronger acidity of the hydroxy group of the naphthalene nucleus of the Arsenazo III molecule as compared with Arsenazo I. The coexistence of the complexes is explained by the considerable structural similarity of their azoid and quinone hydrazone forms. (auth)

2179 OBSERVATION OF A LARGE ISOTOPE EFFECT IN THE MANGANESE DIOXIDE OXIDATION OF BENZYL ALCOHOL. Goldman, I. M. (Chas. Pfizer and Co., Inc., Groton, Conn.). J. Org. Chem., 34: 3289-95(Nov. 1969).

An intramolecular isotope effect for the manganese dioxide oxidation of α-deuteriobenzyl alcohol in benzene solution is determined to be 14.2 ± 0.9, indicating that the rate-determining step for this heterogeneous reaction involves C–H bond cleavage. When equal amounts of benzyl alcohol and α,α-dideuteriobenzyl alcohol are allowed to compete for a limited amount of activated manganese oxide, an isotope effect of 18.2 is observed, presumably resulting from the combined primary and secondary kinetic isotope effects, and indicating that the assumed adsorption step is reversible. A primary adsorptive isotope effect is postulated as a possible explanation for the magnitude of the isotope effect observed. These findings are considered in terms of current concepts about the mechanism of oxidations with activated manganese dioxide. (auth)

2180 DIPHENYLPHOSPHINATE COMPLEXES OF ZIRCONIUM, VANADIUM, AND MOLYBDENUM. Pitts, J. J.; Robinson, M. A.; Trotz, S. I. (Olin Mathieson Research Centre, New Haven). J. Inorg. Nucl. Chem., 31: 3685-90(Nov. 1969).

Characterization of the previously reported Zr complex is described, together with the synthesis and study of some new diphenylphosphinate complexes of V and Mo. Studies included examination of infrared spectra, investigation of thermal stability, and molecular weight determination. Structural formulas are indicated. The complexes included $[(C_6H_5)_2P(O)O]_3\ Zr\ Cl_2$, $[(C_6H_5)_2P(O)O]_4\ Zr$, $[(C_6H_5)_2P(O)O]_3V$, $[(C_6H_5)_2P(O)O]_2VO$, and $[(C_6H_5)_2P(O)(O)]_2VO$. (UK)

2181 ON A FAMILY OF OD-STRUCTURES OF URANYL ACETYLACETONATE. Dornberger-Schiff, Katharina; Titze, Heinz (Institut fuer Strukturforschung, Berlin. Chalmers Technical Univ., Goteborg. Univ. of Goteborg). Acta Chem. Scand., 23: 1685-94(1969).

Crystals of uranyl acetylacetonate obtained on crystallization show different diffraction diagrams. All of them can, however, be explained as originating from members of one and the same family of OD-structures. Two possibilities for the OD-groupoid family are given. Approximate uranium coordinates were obtained from qualitative observations concerning the diffuse streaks. They are: $x_U = 0$; $y_U = 0.25$; $z_U = 0.052$. These are in accordance with the predominant maxima of the Patterson projections P(u,w) and P(u,v) for the monoclinic form. (auth)

2182 DEUTERIUM ISOTOPE EFFECT IN SINGLET → TRIPLET RADIATIONLESS TRANSITIONS OF BENZENE AND BENZENE-d_6. Breuer, George M.; Lee, Edward K. C. (Univ. of California, Irvine). J. Chem. Phys., 51: 3615-16(Oct. 15, 1969).

The fluorescence decay time of C_6D_6 in the gas phase was measured by nanosecond-pulse fluorometry. The intramolecular radiationless decay constant for C_6D_6 was determined to be 0.5 or half that of C_6H_6. (J.G.B.)

2183 NMR STUDY OF THE URANYL 2-THENOYLTRIFLUOROACETONE COMPLEXES WITH LIGANDS. Siddall III, T. H.; Stewart, W. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Inorg. Nucl. Chem., 31: 3557-64(Nov. 1969).

^1H, ^{19}F, and ^{31}P magnetic resonance spectroscopy of the complex molecules $UO_2(TTA)_2 \cdot L$ (TTA = 2-thenoyltrifluoroacetone and L = tributyl phosphate, trioctylphosphine oxide, or dimethylformamide) showed that L is directly bonded to uranium. A pentagonal bipyramidal structure is proposed for these complexes with two out of three possible cis-trans isomers being found. (auth) (UK)

2184 DETERMINATION OF THE No(II)–No(III) POTENTIAL FROM TRACER EXPERIMENTS. Silva, R. J. (Univ. of California, Berkeley); Sikkeland, T.; Nurmia, M.; Ghiorso, A.; Hulet, E. K. J. Inorg. Nucl. Chem., 31: 3405-9(Nov. 1969).

The value of the standard oxidation potential of the No(II)–No(III) couple in aqueous solution was estimated from the average behavior observed during repetitive series of experiments with 50 to 100 atoms per experiment. The distinction between No(II) and No(III) was made on a few atoms-at-a-time basis by multiple solvent extractions with di(2-ethylhexyl)orthophosphoric acid using the column elution technique of extraction chromatography. By comparing the extraction of nobelium from dilute acid solutions containing different oxidants with the extraction behavior of tracer quantities of radioactive elements of known standard oxidation potentials the standard potential of the half-reaction No(II)–No(III) + e^- was estimated to be −1.4 to −1.5 V. (auth) (UK)

2185 CHEMISTRY OF TECHNETIUM IN AQUEOUS SOLUTION. I. THE STATE OF TETRAVALENT TECHNETIUM IN AQUEOUS SOLUTION. Gorski, B.; Koch, H. (Institut fuer Angewandte Radioaktivitaet, Leipzig). J. Inorg. Nucl. Chem., 31: 3565-73(Nov. 1969). (In German).

The state of tetravalent technetium in aqueous solution was studied by means of electrophoresis. The ionic mobilities of different technetium ions were determined, and on this basis conclusions were made on the hydrolysis of the tetravalent technetium. The hydrolysis constants were calculated. (auth) (UK)

2186 SOME UNUSUAL DEUTERIUM ISOTOPE EFFECTS, β VERSUS γ, ON THE POLARIMETRIC RATE OF SOLVOLYSIS OF THREO-1-METHYL-2-PHENYLPROPYL TOLUENE-p-SULPHONATE. Loukas, Spyro L.; Velkou, Margaret R.; Gregoriou, George A. (Democritos Nuclear Research Centre, Athens). J. Chem. Soc., D, No. 20, 1199-1200(1969).

Acetolysis, formolysis, and trifluoroacetolysis of (+)-threo-1-methyl-2-phenylpropyl toluene-p-sulphonate ($H_3C^3 \cdot C^2HPh \cdot C^1H(CH_3)OTs$ (I), and the deuteriated derivatives ($H_3C \cdot CHPh \cdot CH(CD_3)OTs$ (II)), and ($D_3C \cdot CHPh \cdot CH(CH_3)OTs$ (III)) gave isotope effects, k_I/k_{II} versus k_I/k_{III}, of 1.073 versus 1.065, 1.160 versus 1.015, and 1.170 versus 1.009, respectively, which are not satisfactorily interpreted in terms of either a non-classical symmetrical phenonium ion or two rapidly equilibrating classical carbonium ions. (auth) (UK)

2187 MOESSBAUER SPECTRA OF SOME NEPTUNIUM(VII) COMPOUNDS. Stone, J. A.; Pillinger, W. L.; Karraker, D. G. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Inorg. Chem., 8: 2519-20(Nov. 1969).

Mössbauer spectral studies of heptavalent neptunium in three solid environments, including, the hexamminecobalt (III) complex of neptunium(VII), $Co(NH_3)_6NpO_5 \cdot xH_2O$, Np(VII) in NaOH, and ozonized $BaNp_2O_7 \cdot xH_2O$, are reported. Isomer shifts, hyperfine parameter, and intensity data are tabulated. (J.G.B.)

2188 DITHIOLENE CHELATES OF URANIUM WITH CIS-1,2-DICYANOETHYLENE-1,2-DITHIOLATE. Dietzsch, W.; Hoyer, E. (Karl-Marx-Univ., Leipzig). Inorg. Nucl. Chem. Lett., 5: 635-8(Aug. 1969).

UCl_4 gave a brown complex solution with disodium 1,2-dicyano-1,2-dimercaptoethylene in oxygen-free methanol under an inert atmosphere; a crystalline chelate was precipitated with $(C_6H_5)_4AsCl$ and was purified by dissolving in methylene chloride, concentrating under nitrogen, and adding acetone. Analysis and properties show it to be a tetrakis-chelate. A different compound is obtained on repeated recrystallization in air by dissolving in pyridine and adding methanol. Polarographic studies are reported, together with data on infrared spectra, magnetic moments, and conductivities. Other chelates were prepared in solution but could not be isolated. (UK)

2189 ADDITION COMPOUNDS FORMED BY THE PENTACHLORIDES OF NIOBIUM(V), TANTALUM(V), AND PROTACTINIUM(V) WITH NITROSYL CHLORIDE. INFRARED AND RAMAN STUDY. MacCordick, J.; Kaufmann, G.; Rohmer, R. (Univ., Strasbourg). J. Inorg. Nucl. Chem., 31: 3059-70(Oct. 1969). (In French).

Thermal and crystallographic properties and vibrational spectra are reported for the addition compounds $M^VCl_5 \cdot NOCl$ (M = Nb, Ta) and, in part, for a complex analyzed as $PaCl_5 \cdot 3NOCl$. The ionic nature of the products is discussed and spectral data for the anions are presented. (auth) (UK)

2190 ISOTOPE EFFECT ON THE MIGRATION OF STRONG ELECTROLYTES IN AQUEOUS SOLUTION. Perie, Michele; Perie, Jacques; Chemla, Marius (Laboratoire d'Electrochimie, Paris). J. Chim. Phys., 66: 1379-84(July-Aug. 1969). (In French).

The variation of relative mobilities $\epsilon = \Delta u/u$ of isotopic ions resulting from the dissociation of strong electrolytes was studied as a function of the medium concentration by a zone migration technique using paper strips. A first series of runs were devoted to the study of the anions $^{14}NO_3^-$ and $^{15}NO_3^-$. No significant ϵ variation could be detected, in the concentration range studied, and for the different associated cations, so that the isotopic migration effect, in this case, should mainly be a cinetic one. Similar experiments were made with $^6Li^+$ and $^7Li^+$ in NH_4NO_3 and CH_3COONH_4 media. In both cases an increase of the measured isotopic effect was observed with raising concentration that should be imputed to a chemical exchange process between free and associated Li ions. The maximum $\Delta u/u$ values obtained are 1.15% in 16 N nitric solution, and 1.69% in 11 M acetic solution. The large difference between these two results could arise from a different association mechanism in the two media. (auth)

2191 PROTON LIGAND AND METAL LIGAND STABILITY CONSTANTS OF SUBSTITUTED SALICYLALDEHYDES. Vartak, D. G.; Menon, K. R. (Bhabha Atomic Research Centre, Bombay). J. Inorg. Nucl. Chem., 31: 3141-7(Oct. 1969).

Proton affinity constants of β-resorcylaldehyde and gentisicaldehyde and stability constants of the metal complexes of these reagents with UO_2^{2+}, Cu^{2+}, Ni^{2+}, Co^{2+}, Zn^{2+}, Cd^{2+}, and Mg^{2+} are determined in aqueous-dioxane medium containing 50% dioxan by volume and 0.1 M $NaClO_4$ with concentrations of metal ion 10^{-3} M and reagent 10^{-2} M, using the Calvin-Bjerrum pH titration technique. The values for the proton association constants of the reagents are interpreted in terms of inductive effects of substituted groups in benzene. (auth) (UK)

2192 RATE OF OXIDATION OF TETRAVALENT PROTACTINIUM IN TRACE AMOUNTS IN HYDROCHLORIC ACID MEDIUM. Manier, M.; Carlier, R.; Genet, M. (Institut de Physique Nucleaire, Paris). Radiochem. Radioanal. Lett., 2: 133-8(Nov. 20, 1969). (In French).

The oxidation of tetravalent protactinium at tracer concentrations was studied in aqueous hydrochloric acid. The rate of oxidation was measured as a function of [HCl] and the stability of $^{233}Pa(IV)$ was found to decrease with increasing acidity. In these conditions the reaction of oxidation is first order with respect to [$^{233}Pa(IV)$]. The slowest reaction rates were observed at about pH = 1, where hydrolyzed species predominate: the time for half-reaction under these conditions was about two days. (auth)

2193 EXPERIMENTS ON CHEMISTRY OF ELEMENT 103 CHLORIDE ADSORPTION FROM THE GAS STREAM. Chuburkov, Yu. T.; Belov, V. Z.; Tsaletka, R.; Shalaevskii, M. R.; Zvara, I. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Inorg. Nucl. Chem., 31: 3113-18(Oct. 1969).

Element 103 chloride was found to have similar adsorbability on solid surfaces, and hence volatility, to the chlorides of curium, californium, fermium, and element 102 and to be much less volatile than kurchatovium chloride. These first experiments on the chemistry of element 103 performed with ~300 atoms provide evidence that the element is ekalutecium. (auth) (UK)

2194 OPTICAL PHONONS AND PHASE TRANSITIONS IN THE AMMONIUM HALIDES. Perry, C. H.; Lowndes, R. P. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 51: 3648-60(Nov. 1, 1969).

The external optical phonon modes in the ammonium and deuteroammonium halides have been studied through their intrinsic phase transitions in the temperature range 4 to 290°K using infrared and Raman techniques. The number of infrared and Raman active modes are in agreement with group theoretical predictions for the phases II, III, and IV, with the exception that no measurable anisotropic splitting of the out-of-phase mode in the tetragonal phase was observed in the infrared spectra. While the frequency of the infrared reststrahlen modes showed only small discontinuities with temperature as the phase transitions were traversed, the phonon lifetimes of these modes showed distinct increases as the temperature was lowered through each phase transition. Estimates of the intrinsic ionic distortion present in NH_4Cl and NH_4Br are given. The compressibilities of NH_4Cl and NH_4Br at 4°K were calculated to be 3.86×10^{-12} and 6.79×10^{-12} cm^2 dyn^{-1}. (auth)

2195 VIBRATIONAL RELAXATION OF SHOCK-HEATED Cl_2: EFFECTS OF CO, HCl, AND DCl. Breshears, W. D.; Bird, P. F. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 51: 3660-5(Nov. 1, 1969).

The vibrational relaxation of pure Cl_2 in the temperature range 400 to 1400°K, and of binary mixtures of Cl_2 with CO, HCl, and DCl in the range 400 to 1100°K has been studied behind incident shock waves by time-resolved measurement of the postshock density gradient using a laser-beam deflection technique. Results obtained for pure Cl_2 are more precise than those previously available at these temperatures, and are in excellent agreement with lower-temperature ultrasonic data. The effect of CO relative to Cl_2 is found to be much less than indicated by previous data, and is attributed solely to the lower Cl_2–CO reduced collision mass. The effects of HCl and DCl are large, particularly at low temperatures, e.g., HCl is ≈100 times more effective than Cl_2 at 400°K. HCl is ≈2 to 4 times as effective as DCl, depending on the temperature. The relative efficiencies are interpreted as a strong indication of rotational effects. (auth)

2196 MOLECULAR REORIENTATION AND NUCLEAR-SPIN CONVERSION IN THE SOLID DEUTEROMETHANES AT LOW TEMPERATURES. Colwell, Jack H. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 51: 3820-32 (Nov. 1, 1969).

The heat capacities of the solid deuteromethanes have been measured down to 0.3°K, tracing out the low-temperature heat-capacity anomalies which had been detected in the earlier work of Colwell, Gill, and Morrison. The anomalies in CH_3D and CHD_3 have maxima at 0.43 and 0.48°K, respectively, but the CH_2D_2 heat capacity was still increasing with decreasing temperature at 0.3°K. A small anomaly was found in CD_4 but this was ascribed to chemical and isotopic impurities present in the sample. The heat-capacity anomalies were of the Schottky form and believed to arise from the reorientation of the molecules on the lattice sites. This results in the removal of the orientational degeneracies of the molecules which give rise to the zero-point entropies of R ln 4 for CH_3D and CHD_3 and R ln 6 for CH_2D_2. In molecules having identical protons, conversion between the different nuclear-spin states also occurred. This was substantiated in the case of CH_3D where the measured entropy change in the range of the measurements, 0.3 to 4.0°K, was $\Delta S = 1.614R$, which exceeded the maximum value of R ln 4 (1.386R) for molecular reorientation occurring separately. The occurrence of conversion was also indicated by a thermal relaxation process characterized by relaxation times ranging from 110 to 50 sec in going from 0.3 to 4.0°K. Analysis of the CH_2D_2 data indicated that nuclear-spin conversion is also taking place in this material but the result is less well established. There was no indication of conversion occurring in CHD_3. Reasonably precise values of the energy-level splittings have been derived for each of the partially deuterated methanes. (auth)

2197 LOW-FREQUENCY VIBRATIONS IN AMMONIUM IODIDE AND AMMONIUM BROMIDE. Durig, J. R.; Antion, D. J. (Univ. of South Carolina, Columbia). J. Chem. Phys., 51: 3639-47(Nov. 1, 1969).

The far-infrared spectra of thin films of ammonium iodide were recorded from −170°C to room temperature. The results varied with the temperature at which the films were formed thus making the interpretation of the spectra difficult. Laser excited Raman spectra of polycrystalline NH_4I, ND_4I, NH_4Br, and ND_4Br were also recorded in the same temperature range and four lattice vibrations of translatory origin were assigned in the spectrum of the tetragonal phase III of each salt. The energies associated with the $1 \leftarrow 0$ torsional transitions of the ammonium ion in phase III NH_4I and NH_4Br were 287 and 331 cm^{-1}, respectively; the barriers restricting rotation about fourfold axes perpendicular to the crystallographic C axis were calculated to be 3.1 ± 0.1 and 4.0 ± 0.1 kcal/mole, respectively, assuming a harmonic potential and a body-centered cubic lattice. Comparison of the Raman and infrared spectra of the internal fundamentals revealed a large (~30 cm^{-1}) separation between the in-phase and out-of-phase N–H bending frequencies in phase III NH_4I. This result indicates a high degree of coupling between these motions of the two ammonium ions in the unit cell. The Raman spectrum of each ammonium halide in phase II was characterized by a translational mode and a combination band, both of which are forbidden by the rigorous selection rules of the space group. The appearance of these bands has been interpreted in terms of the theory advanced by Whalley and Bertie for optical transitions in orientationally disordered crystals. The reststrahlen frequency in the ordered phase IV ND_4Br has been observed at 141 cm^{-1} in the Raman spectrum of a polycrystalline sample. (auth)

2198 NITROGEN ISOTOPE EFFECTS IN THE REDUCTION OF NITRATE, NITRITE, AND HYDROXYLAMINE TO AMMONIA. II. THE MgO AND $CuSO_4$ SYSTEMS. Brown, L. L.; Drury, J. S. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 51: 3771-5 (Nov. 1, 1969).

Nitrogen kinetic isotope effects were used to study reaction mechanisms associated with reductions of NO_3^-, NO_2^-, and NH_2OH in hot alkaline solutions that contained Fe(II). In the $CuSO_4$ system the specific reaction rate constants varied in the order $k_{NO_2^-} > k_{NO_3^-} > k_{NH_2OH}$, rather than the order $k_{NO_3^-} > k_{NH_2OH} > k_{NO_2^-}$ found previously in the Ag_2SO_4 system. When MgO was used, the order of the specific reaction rate constants was the same as that observed with Ag_2SO_4, but different mechanisms operated in the reduction of NO_3^- and NO_2^-, although not in the reduction of NH_2OH. Reactions consistent with the observed isotope effects and the known chemistry of nitrogen were postulated for the most probable reaction paths in the various systems. (auth)

2199 URANYL OXALATOFLUORIDE COMPLEXES. Lipovskii, A. A.; Nikitina, S. A. Zh. Neorg. Khim., 14: 2127-32(Aug. 1969). (In Russian).

Spectroscopic methods were used to study the formation of uranyl oxalatofluoride complexes by the reactions of $UO_2Ox \cdot 3H_2O$ with UO_2F_2 and trioctylamine (TOA). The existence of benzene-soluble compounds such as $(TOAH)_3UO_2Ox_2F$ and $(TOAH)_3UO_2OxF_3$ was established and their electronic and absorption spectra determined. The solid polymeric compounds $TOAHUO_2OxF$ and $(TOAH)_2(UO_2)_3OxF_6$ were isolated. (M.C.G.)

2200 INVESTIGATION OF THE SOLUBILITY OF PLUTONIUM ARYLARSONATES. Mikhailov, V. A. Zh. Neorg. Khim., 14: 2133-8(Aug. 1969). (In Russian).

The effects of the acidity of the medium and the concentration of reagents on the solubility of compounds formed by plutonium and phenyl-, 4-nitrophenyl-, and 1-naphthylarsonic and phenylphosphonic acids were studied. The reactions of plutonium(III) and (VI) with phenylarsonic acid were studied. It is shown that the minimum solubility of these compounds is close to 10^{-5} mole/l. The constants of precipitation reactions and complex formation of plutonium(IV) with sulfates, fluorides, oxalates, and EDTA were calculated. (tr-auth)

2201 INFRARED SPECTRA OF CRYSTALLINE AND MATRIX ISOLATED PYRIDINE AND PYRIDINE-D_5. Castellucci, E.; Sbrana, G.; Verderame, F. D. (Univ., Florence). J. Chem. Phys., 51: 3762-70(Nov. 1, 1969).

Infrared spectra of pyridine-H_5 and pyridine-D_5 in the solid state were measured between 4000 and 200 cm^{-1}. Frequencies and polarization of fundamental absorptions were established for oriented thin films of freshly crystallized samples. Behavior of the bands in polarized light aided in clarifying several assignments. The multiplicity of several of the bands was accounted for by close-lying overtones and combinations. Some of the components of ν_{16} are due to the existence of appreciable amounts of ^{13}C isotope species clearly observable in a nitrogen matrix at 5°K. For pyridine-D_5 a phase transition was clearly observable after several hours of annealing of thin films at about −60°C, but similar transformation could not be induced in normal pyridine. The infrared crystal data are consistent with an orthorhombic factor group established by x-ray analysis with no molecule on any symmetry element of the crystal. Raman spectra of liquid and solid pyridines are also reported. (auth)

2202 INTERACTION OF TELLURIUM DIOXIDE AND WATER VAPOR. Malinauskas, A. P.; Gooch, J. W. Jr.; Redman, J. D. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol., 8: 52-7(Jan. 1970).

The previously reported enhanced volatility of tellurium dioxide, due to water vapor, was confirmed over the temperature range 825 to 970°K through vapor pressure measurements with a mass transport apparatus. Investigations of the temperature dependence of the characteristic equilibrium constant yield a value of 30.4 kcal/mole for the heat of the (assumed) reaction $TeO_2(s) + H_2O(g) = TeO(OH)_2(g)$. Attempts to identify the gaseous hydroxide species through mass spectrometry were unsuccessful. Mass spectrometer studies of TeO_2 vapor, however, indicated approximately 20% dimer formation within the temperature range 920 to 1050°K. (auth)

2203 ELECTROCHEMICAL MEASUREMENT OF THERMODYNAMIC QUANTITIES IN THE BINARY SYSTEM PRASEODYMIUM–OXYGEN IN THE RANGE O:Pr < 1,714. Lott, U.; Rickert, H.; Keller, C. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 31: 3427-36(Nov. 1969). (In German).

The binary system praseodymium–oxygen was investigated in the range of composition $PrO_{<1.5}$–$PrO_{1.714}$ by emf-measurements on solid-state galvanic cells at temperatures between 500 and 1200°C. In the monophasic region of the sesquioxide Pr_2O_3 no evidence was found for a phase transition from cubic to hexagonal, as has been reported in the literature. Contrary to the literature, a uniform biphasic region Pr_2O_3,Pr_7O_{12} was also found throughout the whole temperature range examined. In the homologous series RE_nO_{2n-2}, postulated for the rare earth oxides, no stable oxides were found to exist for n = 5 and n = 6. Molar free enthalpies, molar enthalpies, and molar entropies of formation of Pr_2O_3 and of oxidation of Pr_2O_3 to Pr_7O_{12}, as well as oxygen partial pressures over the biphasic regions Pr,Pr_2O_3 and Pr_2O_3,Pr_7O_{12}, were calculated and plotted vs temperature. (auth) (UK)

2204 STUDY OF THE SYSTEM ThO_2–UF_4. Fonteneau, Gilles; Lucas, Jacques (Faculte des Sciences, Rennes, France). Compt. Rend., Ser. C; 269: 760-3(6 Oct 1969). (In French).

The system was studied at 1100°C. Thorium dioxide dissolved 22% of UF_4 to give a disordered solid cubic solution $Th_{1-x}U_xO_{2(1-x)}F_{4x}$. From 22 to 38% the system consists of two phases and corresponds to $MOF_2 + Th_{1-x}U_xO_2$. From 38 to 45% there is evidence for the existence of three phases: $MOF_2 + Th_{1-x}U_xO_2 + MF_4$. Beyond that point it again consists of two phases and is made up of $MF_4 + Th_{1-x}U_xO_2$. (tr-auth)

2205 COMPLEXES OF ACTINIDE IONS IN AQUEOUS SOLUTION. Jones, Alan D.; Choppin, Gregory R. (Florida State Univ., Tallahassee). Actinides Rev.; 1: 311-36(Sept 1969).

The chemistry of actinide complexes in aqueous solutions is surveyed. The basic aspects of complexation in terms of the thermodynamics of complex formation and hydration are emphasized. (154 references) (J.G.B.)

2206 THE STABILITY CONSTANTS OF POLYVALENT CATIONS AND AROMATIC ARSONIC ACIDS. II. COMPLEXES OF THE URANYL ION WITH ARSONIC ACID. O'h-Eidhin, M.; O'Cinneide, S. (University Coll., Galway, Ireland). J. Inorg. Nucl. Chem., 31: 2845-51(Sept. 1969).

Stability constants were measured for the complexes of the uranyl ion with 2-hydroxybenzenearsonic acid and 2,4-dihydroxybenzenearsonic acid in aqueous media at 25 ± 0.1°C. Possible structures are postulated for the complexes. Intramolecular hydrogen bonding, which prevents intermolecular association of arsonyl (≡As = O) oxygens with uranyl ions in other molecules of the complexes, may be responsible for the relatively high solubilities compared to those of uranyl complexes with benzenearsonic acid and 4-hydroxybenzenearsonic acid, in which intermolecular association via arsonyl oxygen atoms is possible. (auth) (UK)

2207 INQUIRY CONCERNING THE TEMPERATURE DEPENDENCE OF beta-SECONDARY DEUTERIUM ISOTOPE EFFECTS: SOLVOLYSIS OF ACETYL-d_3 CHLORIDE. Evans, Thomas Ashlie. East Lansing, Mich., Michigan State Univ., 1968. 114p.

Thesis.

The β isotope effect for the solvolysis of acetyl-d_3 chloride was determined over a range of solvents and temperatures. The results of Bender and Feng, k_H/k_D = 1.51 ± 0.07 (90% acetone–water), 1.62 ± 0.08 (80% acetone–water), were not reproduced. The values obtained were much lower, k_H/k_D = 1.059 ± 0.002 (90% acetone–water), 1.106 ± 0.003 (80% acetone–water) (3). The difference between the two sets of results appears in the rate of solvolysis of the hydrogen compound. The temperature dependence of the β isotope effect was determined in 80, 85, 90, and 95% acetone–water. In 80 and 85% acetone–water, the influence of temperature was not detectable beyond experimental error. In 90 and 95% acetone–water, the isotope effect increased with increasing temperature, k_H/k_D (90%) = 1.026 ± 0.010 (−33.68°C), 1.070 ± 0.010 (−9.54°C); k_H/k_D (95%) = 1.004 ± 0.004 (−25.47°C), 1.030 ± 0.007 (−0.20°C). The isotope effect was found to increase with increasing polarity of the solvent: k_H/k_D = 1.004 ± 0.004 (95% acetone–water, −25.47°C, 1.135 ± 0.020 (75% acetone–water, −31.01°C. The observed influence of solvent and temperature is consistent with an activation process. Activation parameters were determined for the solvolysis of acetyl chloride, propionyl chloride, isobutyryl chloride, and pivaloyl chloride. They do not lead to an unequivocal definition of the activation process. It was concluded that because of the ambiguity in defining the transition state of solvolysis, no decision concerning the origin of the isotope effect can be made. (Disser. Abstr.)

Radiation and Nuclear Chemistry

Refer also to abstracts 2266, 2285, 2294, 2394, and 3053.

2208 (ANL-Trans-784) CALCULATION OF THE KINETICS OF AMMONIA RADIOLYSIS IN THE GAS PHASE. I. HYDRAZINE YIELD AS A FUNCTION OF DOSE AND DOSE RATE. Dzantiev, B. G.; Nichipor, G. V. Translated for Argonne National Lab., Ill., from All-Union Institute of Scientific and Technical Information , No. 685-69, 1969. 13p. Dep. CFSTI.

In considering the kinetics of the radiative formation of hydrazine from ammonia, the following three ranges were distinguished: a range of linear time dependence of the radical concentrations and cubic time dependence of the hydrazine concentration; range of quasistationary values of the radical concentrations and linear time dependence of the hydrazine concentration; and range of stationary values of radical and hydrazine concentrations. The reactions that play a major role in the radiolysis mechanism and rate equations of the process are given. It was also found that since the nature of the dependence of hydrazine concentration on dose rate varies with time, the effects of dose rate on energy yield with different contact times are different. In the range of short contact times, the energy yield of N_2H_2 with increasing dose rate passes through a maximum. Data are tabulated. (P.C.H.)

2209 (ANL-Trans-785) CALCULATION OF THE KINETICS OF AMMONIA RADIOLYSIS IN THE GAS PHASE. II. HYDRAZINE YIELD AS A FUNCTION OF TEMPERATURE AND PRESSURE. Dzantiev, B. G.; Nichipor, G. V. Translated for Argonne National Lab., Ill., from All-Union Institute of Scientific and Technical Information, No. 686-69, 1969. 14p. Dep. CFSTI.

The temperature dependence of the nonstationary and stationary hydrazine yield was calculated for the radiolysis of gaseous ammonia in the temperature range T = 300 to 600°K for various dose rates by numerical integration of the chemical rate equations under the assumption of a determining role of H and NH_2 radicals in the mechanism. The influence of pressure on the rate of ammonia decomposition and on the rate of molecular hydrogen formation was studied. An analysis of the relations obtained indicated the existence of three temperature ranges in which the mechanism of hydrazine formation is determined by different elementary processes. The conditions of transition from one range to another depend on the activation energies of the corresponding processes and on the dose rate. A comparison of the calculated data with the experimental ones demonstrated the suitability of the model discussed for describing the temperature dependence of the hydrazine yield. The influence of pressure on this process was considered as a function of the instantaneous contact time, dose rate, and temperature. (auth)

2210 (ANL-Trans-786) CALCULATION OF THE KINETICS OF AMMONIA RADIOLYSIS IN THE GAS PHASE. III. STATIONARY HYDRAZINE YIELD IN THE RADIOLYSIS OF ETHYLENE–AMMONIA MIXTURES. Dzantiev, B. G.; Nichipor, G. V. Translated for Argonne National Lab., Ill., from All-Union Institute of Scientific and Technical Information, No. 687-69, 1969. 10p. Dep. CFSTI.

A mechanism is proposed for the radiolysis of ethylene–ammonia mixtures which permits the explanation of the linear dependence of the stationary hydrazine yield on pressure and the absence of a dependence of α_{max} on p as observed experimentally (under conditions when the dose rate is a linear function of pressure). (α = ethylene concentration and p = pressure.) The hydrazine yield increased by two orders of magnitude at the optimum ethylene concentration when compared with the value of the yield in pure ammonia when the ethylene–ammonia system was irradiated with ^{60}Co γ rays. The decreasing effectiveness of ethylene

additions in passing from light to heavy particles is apparently related to the fact that the spatial distribution of the primary radiolysis products causes not only a predominant recombination of NH_2 radicals, but also decreases the role of hydrogen atoms in the decomposition of hydrazine. (P.C.H.)

2211 (COO-38-642(Rev.)) BIBLIOGRAPHY ON THE RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. II. CARBOHYDRATES. (Notre Dame Univ., Ind. Radiation Lab.). Dec. 1968; Revised Aug. 1969. 14p. Dep. CFSTI.

One hundred and twenty references on the radiation chemistry of carbohydrates in aqueous solutions are listed by year and alphabetically by first author within each year. (M.C.G.)

2212 (ORNL-tr-2251) RADIOLYSIS OF METHANE IN THE PRESENCE OF ISOBUTYLENE. Collin, Guy J.; Herman, Jan Alexander. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from J. Chim. Phys., 66: 496-500(1969). 11p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 28905.

2213 (ORO-3781-6) INVESTIGATIION OF GAMMA-RAY INDUCED POLYMER FORMATION OF THE CARBORANES. Annual Progress Report. Klingen, Theodore J. (Mississippi Univ., University. Dept. of Chemistry). Dec. 1, 1969. Contract AT(40-1)-3781. 44p. Dep. CFSTI.

The γ-induced polymer formation in 1,2-dicarbaclosododecaborane (o-carborane) and its c-alkyl derivatives was investigated. Irradiation of 1-vinyl-0-carborane was carried out on degassed samples. Monomers, dimers, trimers, tetramers, and possibly higher polymeric units were formed. The polymeric mixture was found to be stable to air and water at room temperature. Heating it for extended periods of time above 300°C in air produced no detectable changes in its composition or structure. (M.C.G.)

2214 (UCRL-18983) RADIOLYTIC OXIDATION OF THE PEPTIDE MAIN-CHAIN IN DILUTE AQUEOUS SOLUTION: CHEMISTRY OF THE PEROXY RADICAL, $RCONHC(O_2)R_2$. Kland-English, M. J.; Sokol, H. A.; Garrison, W. M. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1969. Contract W-7405-eng-48. 12p. (CONF-690909-2). Dep. CFSTI.

From 158th National American Chemical Society, New York.

In the γ radiolysis of peptides in dilute O_2-saturated solutions reactions of OH radicals at the main-chain led to formation of the long-lived peroxy radicals $RCONHC(\dot{O}_2)R_2$. Subsequent reactions of these radicals led to main-chain cleavage. A number of competing modes of degradation are involved. A proposed scheme of reactions accounts for the observed product stoichiometries. (auth)

2215 (UCRL-50726) FURTHER STUDIES ON IRRADIATED LITHIUM HYDRIDE: METAL FORMATION AND THERMAL ANNEALING BEHAVIOR. Souers, P. C.; Blake, T. S.; Penpraze, R. M.; Leider, H. R. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 6, 1969. 9p. Dep. CFSTI.

An empirical scale of size for aggregates of lithium metal in irradiated LiH was established using the results of nuclear magnetic resonance and x-ray studies. Some property changes that result from thermal annealing of irradiated LiH are also described. (auth)

2216 STUDIES IN EFFECTS OF γ-RADIATION ON SYNTHETIC FIBRES. I. Potnis, S. P.; Shetty, S. M.; Rao, K. N.; Prakash, Jai (Univ. of Bombay). Angew. Makromol. Chem., 6: 127-35(1969).

Polyester and polyamide yarns were exposed to γ rays with varying doses of irradiation, both in vacuum and in the presence of air. The changes in such properties of the polymers as melting point, relative viscosity, tensile strength, and dye absorption were investigated. The results indicate that, though with higher doses there is degradation of the polymer, under controlled conditions certain desirable properties of the fiber are greatly improved without affecting the mechanical strength. (auth)

2217 EFFECT OF γ-RADIATION ON SYNTHETIC FIBRES. II. IRRADIATION IN THE PRESENCE OF CHEMICALS. Potnis, S. P.; Shetty, S. M.; Prakash, Jai (Univ. of Bombay). Angew. Makromol. Chem., 7: 85-100(1969).

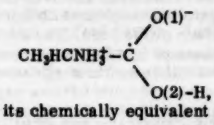
Polyester and polyamide yarns were irradiated under controlled doses of γ rays in the presence of chemicals, such as gaseous ammonia and chlorine and also methyl methacrylate, vinyl acetate, and acrylonitrile monomers. The irradiated monomers have been tested for some of the more important physicochemical and mechanical properties. The results indicate that the improvements obtained in various desirable properties are of much higher order when irradiation is carried out in the presence of the chemicals employed. (auth)

2218 ESR STUDY OF HCO IN SINGLE CRYSTALS OF FORMIC ACID AT 77°K. Holmberg, Robert W. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 51: 3255-60(Oct. 15, 1969).

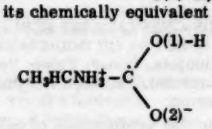
Formyl radicals, HĊO, are formed when crystals of formic acid have been γ irradiated at 77°K are warmed to 195°K. An ESR study of these radicals in single crystals of formic acid was made at 77°K. The g tensor (principal values 2.0037, 2.0023, 1.9948) and the hyperfine tensors for the proton (principal values 337, 346, 378 MHz) and for ^{13}C (principal values 341, 438, 317 MHz) were determined. These tensors are discussed in relation to the structure of the formyl radical. (auth)

2219 ESR STUDY OF STEREOSPECIFIC PROTON TRANSFER IN IRRADIATED CRYSTALS OF L-ALANINE. Miyagawa, Ichiro; Tamura, Naoyuki; Cook, J. W. Jr. (Univ. of Alabama, University). J. Chem. Phys., 51: 3520-8(Oct. 15, 1969).

Crystals of L-alanine irradiated at 80°K were studied with ESR technique. It was found that the proton transfer, which had originally been proposed by Sinclair and Hanna, was stereospecific: The produced species was found to be



and no evidence for its chemically equivalent species



was detected. This stereospecific proton transfer was interpreted on the basis of a quantum-tunneling model, which was found to account for the observed result satisfactorily. A new sample cavity was developed. This cavity has a device which enables one to orient an irradiated crystal to any desired direction, even at 80°K. (auth)

2220 COMPETITIVE ELECTRON ATTACHMENT IN GASEOUS HALOBENZENE–BENZYL CHLORIDE MIXTURES. EVIDENCE FOR ELECTRON TRANSFER FROM THE CHLOROBENZENE ANION TO BENZYL CHLORIDE. Warman, John M.; Sauer, Myran C. Jr.; Johnson, G. R. A. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 3477-84(Oct. 15, 1969).

The yield of benzyl radicals formed by dissociative electron attachment to benzyl chloride in pulse-irradiated gaseous cyclohexane–benzyl chloride mixtures is reduced by the addition of halobenzenes. The results are interpreted in terms of competitive electron scavenging by the halobenzenes and the ratio of the rate constants, $k_{C_6H_5X}/k_{BzCl}$, for electron attachment at 120°C is found to be 20, 0.9, 0.6, and ≤0.005, for iodo-, bromo-, chloro-, and fluorobenzene, respectively. In the case of chlorobenzene, the data do not obey simple competition kinetics. This is explained in terms of the formation of a chlorobenzene anion which subsequently undergoes electron transfer to benzyl chloride in competition with ion recombination. The rate constant for electron transfer is estimated to be 5×10^{-11} cm³/sec. (auth)

2221 LUMINESCENCE KINETICS FOLLOWING PULSE IRRADIATION. II. DNA. Lillicrap, S. C.; Fielden, E. M. (Inst. of Cancer Research, Surrey, Eng.). J. Chem. Phys., 51: 3503-11(Oct. 15, 1969).

The spectra and decay kinetics of the luminescence of calf-thymus DNA following irradiation by 4.3-MeV electrons are reported over a temperature range from 93° to 400°K. The emission is followed by 2 μsec to 1 sec after the start of a 1.6-μsec electron pulse. All the emission spectra observed can be accounted for by the presence of three components with emission peaks at 350, 410, and 470 nm. Emission at 93°K exhibits only 350- and 470-nm components which can be clearly resolved. Apart from the decay of the 350-nm component at 93°K, which follows a reciprocal time–power law, none of the emission decay curves at any temperature can be fitted to a simple mathematical function. It is shown that much if not all the phosphorescence in the temperature range studied results from the trapping of excitation energy. Above 200°K the depths of the traps responsible are distributed about a mean of 0.36 eV and this conclusion is confirmed by thermoluminescent studies. In addition to the decay above, at 93°K the emission at times less than 50 μsec after irradiation depends on the previous dose history of the sample and a possible explanation is presented. (auth)

2222 FREE RADICALS IN PYRIMIDINES: ESR OF GAMMA-IRRADIATED SINGLE CRYSTALS OF ALLOXANTIN.

Benson, Brent; Snipes, Wallace (Pennsylvania State Univ., University Park). Int. J. Radiat. Biol., 15: 583-5(1969).

In an effort to understand the nature of free radical formation in irradiated pyrimidines the ESR spectrum of γ-irradiated single crystals of alloxantin was studied. The principal hyperfine values determined were typical of a radical with the structure $>C-OH$. Such a radical could be formed in alloxantin by hydrogen addition at $O_{(3)}$, $O_{(4)}$, or $O_{(6)}$, but in each case a small amount of nitrogen hyperfine coupling would be expected, and none was observed. The radical must be formed instead by cleavage of the $C_{(5)}-C_{(5')}$ bond joining the two halves of the molecule. Results further confirm the stability of free radicals with unpaired spin density on $C_{(5)}$ on pyrimidines, showing radical formation by a mechanism in addition to those observed previously. (D.H.M.)

2223 EFFECT OF γ-RADIATION ON SYNTHETIC FIBRES. III. ELECTRICAL PROPERTIES AND ELECTRON MICROSCOPE STUDIES. Potnis, S. P.; Shetty, S. M. (Univ. of Bombay). Angew. Makromol. Chem., 8: 117-32(1969).

The effects of γ radiation on the electric properties of polyester and polyamide yarns were studied. Electron photomicrographs were taken to investigate the structural changes occurring due to irradiation on the surface of the yarn. The results indicated that under optimum conditions of irradiation antistatic properties could be imparted to synthetic fibers without affecting the desirable properties. (auth)

2224 EFFECT OF CRYSTALLINE STRUCTURE ON THE TRAPPED RADICAL SPECTRA OF IRRADIATED CELLULOSE. Arthur, Jett C. Jr.; Hinojosa, Oscar; Tripp, Verne W. (Dept. of Agriculture, New Orleans). J. Appl. Polym. Sci., 13: 1497-1507(July 1969).

The effects of crystalline modification of cellulose and of water on the ESR spectra generated by the trapped free radicals in gamma-irradiated celluloses were investigated for cotton cellulose I, II, III, and IV, partially decrystallized cotton cellulose, ball-milled cotton cellulose, hydrocelluloses of cellulose III and IV, and ramie. On irradiation of the celluloses, free radicals were formed on the cellulose molecule, probably following dehydrogenation or chain cleavage. The free radicals located within the less ordered or amorphous regions of the cellulose reacted readily with water and were terminated. The radicals located within the more ordered regions of the celluloses could be made accessible to reaction with water by the interaction of the celluloses with solvents which caused dimensional changes in the cellulosic structure. In the highly ordered regions of the celluloses, even after long periods of time in solvents which caused large dimensional changes in the cellulosic structure, the trapped free radicals were not terminated by reaction with solvent or water. The ESR spectra of the irradiated, dried celluloses were determined at −160°C, the single-line spectra recorded had line widths of about 18 to 24 gauss. On the absorption of water by the irradiated cellulose, the ESR spectra changed and were dependent on the crystalline structure of the irradiated celluloses. The effects of different arrangements of the inter- and intra-molecular bonding forces in the different polymorphic forms of the irradiated celluloses, as shown by their trapped radical spectra, particularly after interaction with water, are discussed. (auth)

2225 OPTICAL DETECTION OF TRANSIENT SOLVATED ELECTRONS IN PULSE-IRRADIATED VISCOUS SQUALANE. Taub, Irwin A. (Carnegie-Mellon Univ., Pittsburgh); Gillis, Hugh A. J. Amer. Chem. Soc., 91: 6507-8(Nov. 5, 1969).

Observations and consequent implications for the nature of electrons in hydrocarbons and the mechanisms of their neutralization are reported. Squalane upon pulse irradiation below −70°C exhibits near-infrared absorption corresponding to a nontrivial yield of a species that decays with complex kinetics in times longer than 10^{-6} sec. Identification of this species as a solvated electron, e^-_s, rests on spectral and kinetics considerations. The optical spectra, determined at −130°C, are very broad and appear to have a maximum in the 1.6 to 1.7 μ region. In the presence of CCl_4 or C_3H_5Br, which are efficient electron scavengers, the absorption intensity and lifetime are both reduced. The yield of e^-_s at −140°C is estimated roughly as 0.6 per 100 eV. The electron decay in squalane has certain factors indicative of an inhomogeneous neutralization of spatially correlated ion pairs. (D.H.M.)

2226 TEMPERATURE DEPENDENCE OF PHOTOCURRENT IN γ-IRRADIATED ALKALINE ICE. LOCATION OF ENERGY LEVELS OF TRAPPED ELECTRONS. Eisele, I.; Lapple, R.; Kevan, L. (Univ. of Kansas, Lawrence). J. Amer. Chem. Soc., 91: 6504-5(Nov. 5, 1969).

An observation of photocurrent and its temperature dependence in the radiolysis of alkaline ice is reported. The peak photocurrent was slightly higher at 4°K than at 77°K. However, between 74 and 111°K the peak photocurrent increased with temperature (indicating the presence of shallow traps near the conduction band). A plot of peak photocurrent vs reciprocal temperature is linear and gives an activation energy of 0.4 kcal/mole. (D.H.M.)

2227 TRANSFER ANNEALING IN ^{131}I-DOPED $CsClO_4$ AND $CsIO_4$. Khorana, S.; Wiles, D. R. (Carleton Univ., Ottawa). J. Inorg. Nucl. Chem., 33: 3387-93(Nov. 1969).

Transfer annealing was studied in $CsClO_4$ and $CsIO_4$ doped with ^{131}iodide on the crystal surfaces. Isothermal annealing at 150°C converted the radioactive I^- to IO_3^- in $CsIO_4$, while in $CsClO_4$ both IO_3^- and IO_4^- were produced. The results are discussed in terms of two alternative mechanisms: a single-stage displacement-exchange accompanied by dissociation, and a multi-stage electron transfer reaction. The experiments were not able to discriminate clearly between the two mechanisms. (auth) (UK)

2228 RADIATION-EFFECT CHEMISTRY OF MIXTURES OF SATURATED AND UNSATURATED HYDROCARBONS. Foldiak, Gabor; Cserep, Gyorgy; Stenger, Vilmos; Vojnarovits, Laszlo (Inst. for Isotopes, Budapest). Kem. Kozlem., 31: 415-38(July 10, 1969). (In Hungarian).

A literature survey was made on the chemistry of radiation effects on mixtures of saturated and unsaturated hydrocarbons, and experiments aimed to elucidate the differential radiation effects on mixtures of similar and dissimilar hydrocarbons (saturated and unsaturated), as well as to establish the radiation-effect chemistry reactions between straight and branched-chain alkane mixtures. Experiments were conducted with a ^{60}Co 1800-Ci activity radiation source used at 20 to 25°C with two dose rates, viz., 1.0 and 20 Mrad/hr. The linear mixture rule was found to apply. Pronounced structural effects were found, but the effects of branching were relatively minor. The role of double bonds is discussed. (JPRS)

2229 FORMATION OF FREE RADICALS IN X-IRRADIATED VINYL MERCAPTAN–VINYL PYRROLIDONE COPOLYMERS. Moenig, H.; Ringsdorf, H. (Univ., Freiburg i. B.). Makromol. Chem., 127: 204-13(Sept. 17, 1969). (In German).

The formation and behavior of radioinduced radicals in polyvinylmercaptan and copolymers from vinylmercaptan and N-vinylpyrrolidone were investigated by ESR spectroscopy. RS· radicals were found in all polymers. In the case of the copolymer they were partially formed by chain transfer reactions. The copolymers were not at all or only weakly crosslinked. This can be explained by a protection- or regeneration-effect for the vinylpyrrolidone moieties by the mercaptogroups. (auth)

2230 THE INVESTIGATION OF ACTION OF IONIZING RADIATION ON GLASSES, WHICH WERE ACTIVATED BY SUCCESSIVE METALS. Galimov, D. G.; Karapetyan, G. O.; Yudin, D. M. Izv. Akad. Nauk SSSR, Neorg. Mater., 5: 1386-91(Aug. 1969). (In Russian).

Capture during the γ-irradiation of aluminum phosphate glasses that were alloyed with certain transition metals and Ce and Nd was studied. Effective cross sections of the charge on ions were determined. The effects of the various ions on the radiation stability of the glasses were evaluated. The electron signal with g = 2.001 was identified. It is postulated that this signal results from electrons that are captured in the 3rd orbit of silicon in the SiO_4 tetrahedron. (tr-auth)

2231 HYDROLYSIS OF URANIUM–PLUTONIUM CARBIDE AFTER NEUTRON IRRADIATION TO HIGH BURN-UP. Findlay, J. R.; Moreton-Smith, M. J.; Moss, R. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 31: 3437-46(Nov. 1969).

The hydrolytic reactions of uranium plutonium carbide were studied with the unirradiated material irradiated with neutrons up to 10 atom per cent burnup of the heavy metal atoms. The unirradiated carbide was hydrolysed readily by water and hydrochloric acid and yielded hydrogen and methane with higher alkanes and alkenes in minor yield. Up to 86 per cent of the original carbon was recovered in the gas phase from the monocarbide; lower recoveries were found for preparations containing sesquicarbide. Neutron irradiation profoundly changed the hydrolytic properties of the carbide. The material became inert to water at 80°C, although still reacting readily with hydrochloric acid. The yield of methane from acid hydrolysis decreased with increasing burnup; irradiation at high temperature or post-irradiation heating reduced the magnitude of this effect. The absence of acetylene among the reaction products was consistent with the assumption that alkaline earth and rare earth fission products were accommodated in the monocarbide lattice as a solid solution. (auth)

2232 RADIATION CHEMISTRY OF LIQUID AND GLASSY METHANOL. Dainton, F. S.; Salmon, G. A.; Wardman, P. (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A, 313: 1-30(Oct. 14, 1969).

The methods of pulse radiolysis, low temperature optical and electron spin resonance spectroscopy and chemical analysis of stable products were applied to an investigation of the γ-radiolysis of liquid and glassy methanol. Processes induced by generation of presumed intermediates by photoionization of solutes were also studied using the same techniques. Electrons are trapped in glassy methanol after γ-irradiation at 77°K with a yield $G(e_t^-) = 2.7 \pm 0.3$ and on warming are rendered mobile, ultimately forming an amount of hydrogen equal to $\frac{1}{2}G(e_t^-)$. In contrast, illumination of the irradiated sample at 77°K with visible light decomposes the trapped electron, forming hydrogen and $\dot{C}H_2OH$ or $\dot{C}H_2O^-$ in yield equal to $G(e_t^-)$. The solvated electron in liquid methanol also reacts with the solvent, at a rate faster than the corresponding reaction in water. The addition of sodium methoxide to liquid methanol results in a marked increase in both the yield and lifetime of the solvated electron observed after 0.2 μs irradiation pulse. The optical absorptions and decay parameters of $\dot{C}H_2OH$ and $\dot{C}H_2O^-$ in liquid methanol were obtained; the ultraviolet absorption observed in irradiated methanol glass after removal of the trapped electrons by photo-bleaching is probably due to these two species. Solutions of methanol glass containing silver perchlorate exhibit complex optical and e.s.r. spectra, which provide evidence for several different species, but a complete analysis has not been possible. The radicals expected from the initial ionization event are considered. Results together with published data, are used to predict the reaction of the free radicals $CH_3O\cdot$, $\dot{C}H_2OH$, CH_2O^-, $H\cdot$ and e_s^- or e_t^- in systems of interest, and the relevance of these reactions to some aspects of the radiation chemistry of methanol is discussed. (auth) (UK)

2233 RADIOLYSIS OF TRIETHYLAMINE–3-METHYLPENTANE GLASSES. Dainton, F. S.; Salmon, G. A.; von Sonntag, C. (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A, 313: 31-43(Oct. 14, 1969).

Optical and electron spin resonance spectroscopy were applied to a study of the species trapped in glassy 1:1 mixtures of triethylamine and 3-methylpentane following γ-irradiation at 77°K. Two distinct bands were discernible in the optical spectrum, a band commencing at about 500 nm and with a peak at 1670 nm, which decayed rapidly in the temperature interval 90° to 96°K and which was readily photobleached by light of $\lambda > 400$ nm, is attributed to the trapped electron, e_t^-. The effect of diphenyl on this band indicated that $G(e_t^-) \geq 2.2$. A short wavelength band rising from 500 nm to the limit of observation at 285 nm, which persisted to a higher temperature, ca. 103°K, and which was not photobleached by visible light, is assigned to free radicals, probably $C_6H_{13}\cdot$ and $(C_2H_5)_2\dot{N}CH\cdot CH_3$. The decay of both bands was studied over a range of temperatures. The ESR spectrum of the glassy mixture comprised a narrow singlet ($\Delta H = 3.5$ G) which had the properties expected of the signal due to e_t^- and a broad (170 G) poorly resolved signal may be attributed to the radicals responsible for the uv absorption band. The optical absorption spectrum of the $(C_2H_5)_2\dot{N}CHCH_3$ radical was obtained by pulse radiolysis of triethylamine at room temperature and the kinetics of the decay of this species were characterized. (auth) (UK)

2234 SEPARATION OF CARRIER-FREE ^{206}Bi FROM ^{206}Pb TARGET. Inarida, Mariko; Shimamura, Akira (Inst. of Physical and Chemical Research, Saitama, Japan). Radioisotopes (Tokyo), 18: 485-7(Nov. 1969). (In Japanese).

Separation of carrier-free ^{206}Bi from a ^{206}Pb target bombarded by 19-MeV deuterons obtained from the 160-cm IPCR cyclotron was studied. The bombarded lead nitrate (enriched $^{208}Pb(NO_3)_2$) was dissolved in 0.1 M nitric acid and 0.2 M oxine–TBP was added, and the two phases were mixed well by one minute shaking. The carrier-free ^{206}Bi was separated by extraction with 0.2 M oxine–TBP and then back-extracted into concentrated HNO_3. The recovery efficiency was about 95%. Carrier-free ^{206}Bi with sufficiently high radiochemical purity was obtained by this simple procedure. (auth)

2235 PREPARATION OF CARRIER-FREE ^{99}Mo BY MEANS OF (n,γ) RECOIL. Colonomos, M.; Parker, W. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Radiochim. Acta, 12: 163-4(Oct. 1969).

An investigation concerning the possibility of obtaining an enrichment of ^{99}Mo by means of (n,γ) recoil was carried out. The molybdenum compound made used was $Mo(CO)_6$ mixed, in varying ratios, with an oxalic catcher. Recoil activity was analyzed as a function of the concentration of $Mo(CO)_6$ in the catcher and also as a function of irradiation time. Parameters, influencing preparation of the samples as well as the received γ dose, were taken into consideration. The principle of the procedure can be used for the preparation of carrier-free ^{99}Mo using short irradiation times from 4 to 8 hrs at fluxes of the order of 10^{12} n/cm^2 sec. (auth)

2236 ENERGY TRANSFER IN AROMATIC SOLUTIONS. PART II. THE INFLUENCE OF PHENANTHRENE ON THE ^{60}Co-γ-INDUCED ISOMERIZATION OF STILBENE IN BENZENE AT 25°C. Ehrl, A.; Woolley-Hart, A. (Gesellschaft fuer Strahlenforschung, Neuherberg, Ger.). Atomkernenergie, 14: 435-40 (Nov.–Dec. 1969).

The yield of the ^{60}Co γ-induced isomerization of 25°C of cis- and trans-stilbene, dissolved in benzene, was increased by phenanthrene. This influence is explained by fluorescence measurements: Isomerization required a quantum energy transfer from the excited benzene to the stilbene. Part of the excited benzene molecules was self-quenched and ineffective for isomerization. Phenanthrene competed with this self-quenching process without influencing the primary energy transfer from benzene to stilbene. In its presence quantum energy was transferred additionally by two steps from benzene via phenanthrene to either cis- or trans-stilbene. The dose-yield of the isomerization was therefore improved. (auth)

2237 CHANGES IN ATROPINE SULFATE INDUCED BY Co GAMMA RADIATIONS. Cospito, M.; Contarini, M.; Gangemi, G. (Istituto Chimico Farmaceutico Militare, Florence). Boll. Chim. Farm., 106: 109-14(Feb. 1967). (In Italian).

The radiolytic decomposition of an aqueous solution of atropine sulphate irradiated with gamma rays from a ^{60}Co was studied. The concentration changes and the absorption spectrum modification vs absorbed dose were considered. Tropine and tropic acid were identified among the products of the radiolytic decomposition. (auth)

2238 LUMINESCENCE IN HIGH-ENERGY-IRRADIATED ALKANES AT LOW TEMPERATURE. Burton, Milton; Funabashi, Koichi (Univ. of Notre Dame, Ind.). Mol. Cryst., 6: 153-81(1969). (COO–38–588).

When suitable alkanes are reduced to sufficiently low temperature (e.g., 77°K), irradiation with ^{60}Co gammas produces a persistent luminescence, the decay curves of which show peculiar behavior characteristics. This report reviews the decay characteristics and spectra of glassy 2-methylpentane and 3-methylpentane as well as of glassy and crystalline i-pentane, reexamines the kinetics and the mechanism of the luminescence process, interprets the applicability of the decay law $I_0/I = 1 + \alpha t$, demonstrates that an excited state of the system (probably a charge-separated state) and not of an individual molecule is involved, presents evidence that the number of available (A and B type) luminescence sites is limited and depends on the history of the system, and suggests that the nature of the emitting state may change with temperature. An important aspect of the theoretical considerations is that they suggest that at sufficiently low temperatures such luminescence can be observed even for hydrocarbons as simple as methane. The most recent work of Janssen, Lang, Hebert, and the authors shows that, although luminescence can be induced in hydrogen and the lower alkanes by irradiation of polycrystalline material at sufficiently low temperature, it appears only when the temperature is raised to certain definite temperatures characteristics of each of the alkanes. Some of these temperatures correspond to known transition points; others may correspond to other solid-state changes. (auth)

2239 RADIOCHEMICAL POLYMERIZATION OF ACRYLONITRILE IN THE SOLID PHASE. Vladzhiu, I. (Dept. of Physical Chemistry, Bucharest). Rev. Roum. Chim., 14: 767-71 (June 1969). (In Russian).

Radiochemical polymerization of acrylonitrile in organic solvents and in the presence of solid impurities was studied at −78°C and at an irradiation dose of 2.17×10^{17} eV/min. Polymerization of acrylonitrile took place in dimethylformamide, triethylamine, propylamine, and diethylenetriamine, but it did not polymerize in dimethyl sulfoxide or ethylene carbonate. Silver nitrate and copper chloride with 0.2% concentration increase the rate of polymerization reaction in dimethylformamide. (R.V.J.)

2240 PRODUCTS FORMED AT 77°K BY THE IRRADIATION OF SOLID CHLOROTRIPHENYLMETHANE AND TEMPERATURE OF DIFFUSION OF CHLORINE ATOMS AND IONS. Brot, Claude; Deroulede, Alain; Gheifenstein, Michel; Kieffer, Fernand; Magat, Michel; Roncin, Jacques (Laboratoire de Physico-Chimie des Rayonnements, Orsay, France). J. Chim. Phys., 66: 1207-12(July-Aug. 1969). (In French).

By combining data obtained from electron spin resonance, nuclear magnetic resonance, radiothermoluminescence, and radiophotoluminescence, it is shown that the paramagnetic species that are present at 77°K in chlorotriphenylmethane after γ irradiation at this temperature are the triphenylmethyl radical and the Cl_2^- ion. A discussion of possible mechanisms of formation of Cl_2^-

leads to the following reaction scheme: $(C_6H_5)_3\ CCl \rightsquigarrow (C_6H_5)_3\ CCl^*$; $(C_6H_5)_3\ CCl^* \rightarrow (C_6H_5)_3\ C^+ + Cl^*$; $(C_6H_5)_3\ CCl + e^- \rightarrow (C_6H_5)_3\ C^* + Cl^-$; $Cl^- + Cl^* \rightarrow Cl_2^-$. It follows that in chlorotriphenylmethane crystals diffusion of chlorine atoms and ions is possible at temperatures of 77°K or lower. (auth)

2241 MECHANISMS AND ISOTOPE EFFECTS IN THE REACTIONS OF ENERGETIC CARBON ATOMS WITH HYDROCARBONS AND ALKYLFLUORIDES. Ache, Hans J.; Christman, David R.; Wolf, Alfred P. (Brookhaven National Lab., Upton, N. Y.). Radiochim. Acta, 12: 121-30(Oct. 1969).

Carbon-11-atoms were allowed to react with specifically deuterated and perdeuterated hydrocarbons and also with specifically deuterated and perdeuterated alkylfluorides, all in the presence of oxygen scavenger. In addition the reactions of ^{11}C atoms with protonated and perdeuterated hydrocarbons or protonated and perdeuterated alkylfluorides in 1 : 1 mixtures containing oxygen scavenger were studied. The major fraction (>90% in the 1 : 1 mixtures) of the acetylene-^{11}C formed in these reactions was in the form of the specifically labeled acetylenes, $H^{11}C \equiv CH$ and $D^{11}C \equiv CD$. The overall isotope effect as measured by the ratio of yield, $H^{11}C \equiv CH/D^{11}C \equiv CD$ varies from 1.05 for aromatics such as benzene to 1.27 for aliphatics such as methane. Increased isotopic mixing observed in acetylene-^{11}C yields from specifically labeled hydrocarbons reflects both the intramolecular nature of the reaction and the lifetime and excitation energy of the ^{11}C containing intermediate. The isotope effects and mixing effects are discussed in light of the current hot-carbon-atom reaction hypothesis. (auth)

2242 STEP-ANNEALING STUDY OF NEUTRON IRRADIATED CHROMATES. Marques, R. O.; Wolschrijn, R. A. (Reactor Centrum Nederland, Petten). Radiochim. Acta, 12: 169-71(Oct. 1969).

Results are reported of experiments performed to find correlation between thermal annealing behavior of different neutron-irradiated chromates and their intrinsic properties. Composite step-annealing curves were plotted for K_2CrO_4, $Na_2CrO_4 \cdot 4H_2O$, and Na_2CrO_4 (non-aquo). One of the striking features of the annealing curves of K_2CrO_4 and $Na_2CrO_4 \cdot 4H_2O$ is that at most temperatures no tendency is found of reaching a constant values within 20 to 80 hr. The annealing curve of Na_2CrO_4 differs from those of other chromates by having at most temperatures a nearly horizontal plateau: the major part of the annealing takes place the first few hours after a temperature change. (D.H.M.)

2243 RECOIL ATOM BEHAVIOR OF α- AND β-ZINC PHTHALOCYANINES. Yang, Mo-hsiung (Japan Atomic Energy Research Inst., Tokai, Japan). Radiochim. Acta, 12: 167-9(Oct. 1969).

The effects of crystal structure on the behavior of recoil atoms of α- and β-zinc phthalocyanines were investigated with special attention paid to the "isotope effects" for ^{69m}Zn and ^{65}Zn. Results show that initial retention was higher for the β-form in which annealing in Stage I is also far more important. This suggests that Stage I of the annealing is essentially the same process that also determined the "initial" retention. Stage II is evidently determined by quite different factors. (D.H.M.)

2244 ELECTRODIALYSIS THROUGH ION EXCHANGE MEMBRANES FOR SEPARATION OF CARRIER-FREE RADIONUCLIDES. I. PRODUCTION OF CARRIER-FREE ^{90}Y FROM ^{90}Sr-^{90}Y EQUILIBRIUM MIXTURES. Groll, P; Grass, F.; Buchtela, K. (Univ., Vienna. Oesterreichische Hochschule, Vienna). Radiochim. Acta, 12: 152-6(Oct. 1969). (In German).

Yttrium-90 was separated from its mother nuclide ^{90}Sr by electrodialysis of the EDTA-complexes, using membranes of anion exchangers. The flowsheet of the apparatus is shown. Measurement of the decay curve over 1800 hrs gave the half-life of ^{90}Y at 63.46 ± 0.13 hrs. The method yields 42% of ^{90}Y. The decontamination factor of 2.2×10^7 is sufficient for medical uses. (auth)

2245 KINETIC STUDY OF γ-RADIATION-INDUCED POLYMERIZATION OF ETHYLENE IN THE PRESENCE OF ACETYLENE. Mitsui, Hiroshi; Hosoi, Fumio; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part A-1, 7: 2575-86(Sept. 1969).

The effects of acetylene on the γ-induced polymerization of ethylene were studied from the viewpoint of kinetics. The experiments were carried out under a pressure of 150 to 400 kg/cm^2; the temperature was 30°C; the dose rates were 2.7×10^4 and 1.1×10^5 rad/hr; the acetylene content was 0 to 2.21%. Both the polymer yield and the molecular weight increased acceleratively with the reaction pressure in the polymerization containing 0.18% acetylene. The yield increased almost proportionally with the dose rate, and the molecular weight was found to be almost independent of the dose rate in the polymerization containing 2.21% acetylene. The polymerization rate and the molecular weight increased with reaction time, but the increment decreased with increasing acetylene content. The degree of increase in the molecular weight also decreased with increasing time. These results were analyzed by using a graphical evaluation method for kinetics, and the effects of acetylene on each elementary step in the polymerization were discussed. (auth)

2246 RADIATION-INDUCED POLYMERIZATION OF 1,1,2-TRICHLOROBUTADIENE IN THE SOLID STATE. Ito, Katsukiyo; Matsuda, Tatsuo (Government Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part A-1, 7: 2711-14(Sept. 1969).

Changes in the polymerization and in the structure of the polymer formed during the course of polymerization of 1,1,2-trichlorobutadiene in the solid state were studied. It was observed that the rate of polymerization and the molecular weight of the polymers formed increase with increasing conversion. The content of 1,4 units in the polymer also increases with increasing conversion. (auth)

2247 RADIATION CHEMICAL STUDIES OF PROTEIN REACTIONS: EFFECT OF RADIATION ON THE BREAKING OF SECONDARY BONDING IN PROTEIN. Nisizawa, Mizuho (Defense Academy, Yokosuka, Japan). J. Polym. Sci., Part A-1, 7: 2715-18(Sept. 1969).

The effect of radiation on the breaking of secondary bonding in protein was studied by measuring the viscosity change at different radiation doses and urea concentrations. An experimental equation for the viscosity change was obtained, and the observed behavior was explained on the basis of the molecular mechanism. The general equation for the viscosity change is given by $\eta_{red} = A(X - Be^{-kx}) + C \log R$, where η_{red} is the reduced viscosity of the solution, R is the dose of γ-radiation, X is the concentration of urea, and A, B, C, and k are adjustable constants. (auth)

2248 BUBBLE FORMATION IN RADIATION-INDUCED GRAFTING OF STYRENE TO POLYETHYLENE. Machi, Sueo; Silverman, Joseph (Univ. of Maryland, College Park). J. Polym. Sci., Part A-1, 7: 2737-40(Sept. 1969).

Studies on the formation of bubbles in a polyethylene film grafted with styrene by a simultaneous irradiation technique are reported. Just after the γ irradiation no bubbles were observed in the film, and even under examination by optical microscopy it appeared to be homogeneous. After prolonged soaking in benzene, however, bubbles appeared and were observed to grow in size and number with increasing soaking time until the bubbles overlapped and coalesced. (auth)

2249 DURABILITY AND CREEP OF POLYMERS IN RADIATION FIELD. Stepanov, V. F.; Vaisberg, S. E.; Karpov, V. L. Fiz.-Khim. Mekh. Mater., 5: 306-13(1969). (In Russian).

The effects of electron irradiation on the durability and creep of standard Kapron (a nylon-like synthetic fiber) in nitrogen and air were studied. A reversible effect on the increase of rate of creep was shown. A sharp dependence of the durability and rate of creep on the intensity of irradiation, the magnitude of the load, temperature, and the atmosphere surrounding the specimen was shown. A formula for the description of the rate of creep and the durability of the polymers in the irradiation field was proposed and correlated with the formula of electron conductivity of dielectrics during irradiation. (tr-auth)

2250 A STUDY OF THE COMBINED EFFECTS OF ACTIVE LIQUID MEDIUMS AND GAMMA RADIATION ON THE DURABILITY OF POLY(METHYL METHACRYLATE). Tynnyi, A. N.; Bazilevich, Z. A.; Mikitishin, S. I.; Lavrentovich, Ya. I.; Karpenko, G. V. (Inst. of Physical-Mechanical, Lvov. Inst. of Physical Chemistry, Kiev.). Fiz.-Khim. Mekh. Mater., 5: 314-17(1969). (In Russian).

The combined effects of tension, active liquid medium and γ radiation on the durability and creep of poly(methyl methacrylate) were studied. The durability of PMMA was determined, up to an adsorption of 10 MRad, basically by the action of the liquid media. It was also observed that γ radiation increases the rate of creep of PMMA in liquid media. (tr-auth)

2251 EPR AND IR STUDY OF THE RELATION BETWEEN CHANGES OF MECHANICAL PROPERTIES AND CHEMICAL STRUCTURE OF REINFORCED PLASTICS AND EPOXIDE BINDING UPON ELECTRON IRRADIATION. Barbashov, E. A.; Bogatov, V. A.; Kozyreva, R. I.; Kiselev, B. A.; Panshin, B. I.; Perov, B. V.; Chubarova, M. A. Fiz.-Khim. Mekh. Mater., 5: 318-22 (1969). (In Russian).

The effects of irradiation with 2-MeV electrons on the mechanical properties of fiberglass-reinforced plastic EDT-10 and SGMA, and also on textolite binding of EDT with dacron fiber filler were

studied. Electron paramagnetic resonance and infrared spectroscopy were used to study the structural changes that emerged in the materials. A comparison of the EPR spectra and the free radical yield permitted the establishment of a chemical reaction between the binding and the glass fiber in the fiberglass-reinforced plastic EDT-10. (tr-auth)

2252 FERROUS SULPHATE G-VALUES IN 0.8 AND 0.1N H_2SO_4. Day, M. J. (Newcastle General Hospital, Newcastle-on-Tyne, Eng.); Law, J. Phys. Med. Biol., 14: 665-7(Oct. 1969).

Ferrous sulphate G values in 0.1 and 0.8N H_2SO_4, determined by different groups of investigators, are compared. The ratios of the G values fall into two groups at around 1.015 and 1.03. It is suggested that the discrepancy lies in the different irradiation conditions used by the investigators. (UK)

2253 NANOSECOND PULSE RADIOLYSIS OF LIQUID NAPHTHALENE AND BIPHENYL. Theard, L. M. (Gulf General Atomic Inc., San Diego, Calif.); Peterson, F. C.; Holroyd, R. A. J. Chem. Phys., 51: 4126-32(Nov. 1, 1969).

The pulse radiolysis of liquid naphthalene and biphenyl was investigated with nanosecond time resolution. In naphthalene, excited species in both singlet and triplet states were observed. The fluorescence spectrum showed that the excited singlet is present to a large extent as the excimer. A short-lived ($\tau_{\frac{1}{2}} < 100$ nsec) transient absorbing broadly in the 450 to 575-mμ spectral region was observed, the decay of which corresponded to the decay of the fluorescence. This short-lived species is suggested to be the naphthalene excimer. The formation of triplet states by crossover from the first excited singlet state (ISC) is of minor importance in the radiolysis of molten naphthalene. When 1,2-benzanthracene was added to the naphthalene, absorption by the first excited singlet state of 1,2-benzanthracene was observed. In the pulse radiolysis of molten biphenyl at 100°C most of the ions recombine in less than 10 nsec; thus triplet excited states formed by ion recombination are expected to be present 10 nsec after the pulse. The fluorescence indicated that two excited singlet states of biphenyl are present. (auth)

2254 MOESSBAUER-EFFECT AND INFRARED-ABSORPTION STUDY OF THE RADIOLYSIS PRODUCTS OF POTASSIUM TRISOXALATOFERRATE(III). Temperley, A. A.; Pumplin, D. W. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). J. Inorg. Nucl. Chem., 31: 2711-25(Sept. 1969).

The principal radiolysis products were identified as cis and trans isomers of potassium bisoxalatobisaquoferrate(II). Room temperature measurements of the quadrupole splittings were: $\epsilon_{cis} = (2.58 \pm 0.03)$ mm/sec, $\epsilon_{trans} = (3.90 \pm 0.04)$ mm/sec; and of the chemical shifts with respect to sodium nitroprusside: $\delta_{cis} = (1.48 \pm 0.03)$ mm/sec., $\delta_{trans} = (1.42 \pm 0.03)$ mm/sec. Evidence was also seen for three additional compounds, both in irradiated samples of potassium trisoxalatoferrate(III) and in synthesized K-Fe(II)-C_2O_4 complexes. One of these was identified as potassium bisoxalatobisaquoferrate(III), with $\epsilon = (0.69 \pm 0.03)$ mm/sec and $\delta = (0.66 \pm 0.03)$ mm/sec. Possible assignments for the others are discussed. (auth) (UK)

2255 RADIATION CHEMISTRY OF SYSTEMS CONTAINING PHOSPHINE. Buchanan, James Wesley. Gainesville, Fla., Univ. of Florida, 1968. 87p.

Thesis.

Comparison studies of the decomposition of pure phosphine and pure ammonia by ^{60}Co gamma rays show that both compounds are broken down to their elemental constituents. Results of mass balance experiments with pure phosphine indicate that the overall radiolysis reaction is $PH_3 \rightsquigarrow P_{red} + \frac{3}{2} H_2$. G for hydrogen production is 11.3 molecules formed per 100 eV absorbed energy, over the dose range 0.4×10^{20} eV to 5×10^{20} eV, beyond which the G-value decreases. From 50 torr to one atmosphere the product yield is proportional to phosphine pressure, extrapolating to zero yield at zero pressure. Yields of nitrogen and hydrogen from the radiolysis of ammonia are proportional to dose from 1×10^{20} to 5×10^{20} eV, with G-values of 1.5 and 4.5, respectively. The total product yields extrapolate to zero yield at zero dose. The G-values are not dependent on ammonia pressure from 100 torr to one atmosphere, and the product yields extrapolate to zero at zero pressure. Measurement of nitrogen by two methods gives very close agreement and indicates that the formation of hydrazine is insignificant. Irradiation of gaseous mixtures of ammonia and phosphine yields hydrogen, red phosphorus, and nitrogen. Attempts to find other products were unsuccessful. Hydrogen yields were larger than predicted from the assumption of an "ideal" mixture, in which the ammonia and phosphine decompose proportionately to the dose each absorbs, but nitrogen yields show a striking depression. Phosphine appears to be acting as an efficient radical scavenger, via reactions such as $NH_4^+ + PH_3 \rightarrow NH_3 + PH_4^+$ and $H^* + PH_3 \rightarrow H_2 + PH_2^*$. The phosphino radical reacts further to yield (finally) phosphorus and hydrogen. By comparing the radiolytic decomposition of ammonia in a mixture containing a few mole percent phosphine and in the pure state, it can be shown that roughly one phosphine is removed for each ammonia that is prevented from decomposing in the mixture. This "protective" effect occurs via radical scavenging reactions, since scavenging of aminos re-forms ammonia and scavenging of hydrogen atoms suppresses the reaction of H with ammonia. A limited study was made of the γ radiolysis of methyl iodide vapor and mixtures of phosphine and methyl iodide. Analyses of methane and hydrogen yields from irradiation of the pure vapor at 27 cm pressure show that both are proportional to absorbed dose from 1×10^{20} eV to 4×10^{20} eV, with $G(CH_4) = 2.3$ and $G(H_2) = 0.6$. The initial (zero dose) G-values for methane and hydrogen are 1.7 and 1.4, respectively. Both yields show a dependence on methyl iodide pressure. $G(CH_4)$ is decidedly greater above 20 cm pressure, but $G(H_2)$ falls off. The mechanism for methane production is presumed to involve hot methyl radicals. Hydrogen production may be via a molecular elimination or hot atom process. Those mixtures containing a few mole percent phosphine show a greatly enhanced methane yield. A maximum $G(CH_4)$ of 12.6 occurs in a mixture containing 3.5 mole percent phosphine and in which 99% of the radiation dose is absorbed by methyl iodide. This yield probably approximates the G for methyl radical production in pure methyl iodide vapor. In mixtures with greater phosphine concentrations the methane yield falls off sharply and the hydrogen yield shows a large increase, perhaps due to an energy transfer process. As the phosphine concentration becomes relatively large, the yields become functions only of the energy absorbed by phosphine. (Disser. Abstr.)

Radiochemistry

2256 (ORNL-tr-1660) ACTIVITY LOSSES IN HANDLING AQUEOUS SOLUTIONS OF ^{131}I. Moldenhawer, F.; Uhlig, B. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Isotopenpraxis, 2: 333-8(1966). 12p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 1412.

2257 REACTIONS OF ^{144}Ce IN SOLUTION AND SUSPENSIONS OF SOIL HUMIC ACID AND BENTONITE. Brown, R. E.; Franklin, R. E.; Miller, R. H. (Ohio Agricultural Research and Development Center, Wooster. Ohio State Univ., Columbus). Soil Sci. Soc. Amer., Proc., 33: 677-81(Sept.-Oct. 1969).

A study was made of the formation of radiocolloids by ^{144}Ce and the adsorption of Ce by equilibrated suspensions of humic acid, bentonite clay, and a mixture of these two colloids saturated with either Ca or K and H. The availability of Ce in these suspensions was measured using excised roots. Ionic strength, Ce concentration, and pH were critical factors affecting the equilibrium between radiocolloidal and monomeric Ce. As ionic strength and Ce concentration decrease and as pH increases the equilibrium is shifted towards the radiocolloidal form of Ce. At pH 6.5 and ionic strength 10^{-3} about 90% of the Ce in a solution is in the radiocolloidal form. A multiple regression equation is presented which shows the effects of pH, ionic strength, and Ce concentration on the formation of radiocolloidal Ce in salt solutions. Humic acid absorbed much greater amounts of ^{144}Ce and restricted uptake by barley and soybean roots more than did bentonite in the Ca-H saturated system. However, humic acid and bentonite absorbed similar amounts of ^{144}Ce in the K-H saturated systems. Mixing bentonite and humic acid produced a synergistic-type effect in regard to Ce adsorption. It was proposed that the strong bonding of Ce by Ca-humic acid and humic acid-bentonite mixtures resulted from a more favorable orientation of the humic acid molecule for chelation of Ce. (auth)

2258 THE CHEMICAL FORMS OF STABILIZED ATOMS OF RADIORHENIUM FORMED BY THE IRRADIATION OF SOME RHENIUM COMPOUNDS WITH PROTONS AT 660 MeV. Ianovici, E.; Zaitseva, N. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Inorg. Nucl. Chem. 31: 3309-10(Oct. 1969).

A study of the chemical forms of radiorhenium formed by the Re(p,pxn)Re* nuclear reaction with 660-MeV protons is presented. Studies are described on the perrhenates of potassium, sodium, and ammonium, and on potassium chlororhenite. (UK)

Separation Processes

Refer also to abstracts 2093, 2102, 2129, 2168, 2244, 2394, 2436, 2985, 4004, and 4023.

2259 (AERE-R-6153) AN IMPROVED PHOSPHATE–FERROCYANIDE/VERMICULITE TREATMENT FOR HARWELL MEDIUM LEVEL EFFLUENT. Clarke, J. H.; Cumberland, R. F.; Smyth, M. J. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1969. 14p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

Investigations into the reported poor decontamination of certain AERE radioactive effluents by vermiculite after treatment by a combined calcium phosphate–copper ferrocyanide precipitation are described. Results indicated that poor performance only occurred with effluents that contained a high phosphate ion concentration and had a low pH value. Considerable improvement was found by substituting zinc ferrocyanide for the copper salt. (UK)

2260 (ANL-7568) GLOVEBOX FACILITY FOR PYROCHEMICAL RESEARCH AND DEVELOPMENT WORK WITH ^{238}Pu. Fischer, J. (Argonne National Lab., Ill.). May 1969. Contract W-31-109-eng-38. 42p. Dep. CFSTI.

A detailed description of a facility for conducting pyrochemical research and development work with plutonium-238 is given. The facility is comprised of a negative-pressure glovebox containing both a high-purity helium and an air-atmosphere section for experimental work, and an air-atmosphere glovebox for analytical work. The general capabilities of the facility are discussed, and the gloveboxes and associated equipment are described in detail. Equipment items include furnaces, gloves, utilities, cooling-water and vacuum systems, and instrumentation for temperature measurement and for atmosphere purification and control. (auth)

2261 (ARH-1154) PROBLEMS ASSOCIATED WITH ^{238}Pu PROCESSING. Case, A. H. (Atlantic Richfield Hanford Co., Richland, Wash.). July 1969. Contract AT(45-1)-2130. 10p. Dep. CFSTI.

Because of its greater disintegration rate, plutonium-238 processing presents some problems that are not found in working with plutonium-239. These problems and special equipment and techniques that have been used successfully are described. (auth)

2262 (BNWL-1205) SURVEY OF FUEL REPROCESSOR PLANS FOR RECOVERING NEPTUNIUM AND A PROJECTION OF NEPTUNIUM QUANTITIES AVAILABLE THROUGH 1980. McKee, R. W.; Nunn, S. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1969. Contract AT(45-1)-1830. 24p. Dep. CFSTI.

Substantial facilities for recovering neptunium from spent power reactor fuels are presently scheduled even though there is no neptunium market at the present time. Estimates are given to show that during the period 1970 to 1980, the neptunium recovered could range from 9 to 12 kg/yr in 1970 and from 700 to 1100 kg/yr in 1980. (auth)

2263 (CEA-CONF-1316) REGULATION AND AUTOMATION IN A PLANT FOR REPROCESSING OF IRRADIATED FUELS. Martinet, R. (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Mar. 14, 1969. 8p. (In French). (CONF-690626-2). Dep. CFSTI (U. S. Sales Only).

From Meeting on Automation in Nuclear Research and Industry, Grenoble, France.

The reprocessing plant at Marcoule was not originally planned to function automatically because of the economics involved. However, since the process is continuous and the parameters do not vary for a few of the given characteristics, it was possible to automate in the first stages. The partial automations, such as the centralization of numerous measurements, and a judicious choice of materials for measurement and of control resulted, at only a slight cost, in a reduction in the cost of maintenance and exploitation. (P.C.H.)

2264 (CEA-R-3788) APPLICATION OF MERCURY CATHODE ELECTROLYSIS TO FISSION-PRODUCT SEPARATION. Besson, Andre; Prigent, Yvon; Van-Kote, Francis (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Aug. 1969. 23p. (In French). Dep. CFSTI (U. S. Sales Only).

A method involving controlled potential mercury cathode electrolysis has been developed to separate fission products. It allows the radiochemical determination of Ag, Cd, Pd, Rh, Ru, Sn, Te, Sb, and Mo from solutions of fission products highly concentrated in mineral salts. The general procedure consists of three main steps: electrolytic amalgamation, destruction of amalgams, and ultimate purification of elements by other means. Electrolytic operations last about five hours. Chemical yields lie between 10 and 70%. (auth)

2265 (CONF-671056-2) BRITISH VIEW OF REPROCESSING. Williams, J. A. (United Kingdom Atomic Energy Authority, [Sellafield] (England). Production Group). Feb. 1968. 6p.

From Swiss Nuclear Forum, Zurich, Switzerland.

The growth of fuel reprocessing in the United Kingdom is discussed, the reasons for the particular method chosen are given, and alternatives are indicated. (M.C.G.)

2266 (HMI-B-84) ANNUAL RESEARCH REPORT, 1968. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Oct. 1969. 24p. Dep. CFSTI (U. S. Sales Only).

Research progress is reported in the following areas: reactor chemistry, radionuclides; nuclear processes applied to solids; and trace elements, isotope effects, dating. (D.H.M.)

2267 (IN-1316, pp 85-9) IODINE ADSORBERS-REACTOR ATMOSPHERE CLEANUP. (Idaho Nuclear Corp., Idaho Falls).

In the program for cleanup of reactor containment atmosphere, studies have been under way on specific inorganic adsorbers for the retention of airborne radioiodine. Current research has been devoted to evaluating the effects of various atmospheric pollutants upon the adsorption characteristics of Linde Molecular Sieve 13X in the silver form for iodine-131-labeled iodine and iodomethane. (auth)

2268 (NP-18020) SIMULTANEOUS DISTRIBUTION OF NITRIC ACID AND URANYL NITRATE BETWEEN AQUEOUS AND UNDILUTED TRIBUTYL PHOSPHATE PHASES. Eschrich, H.; Hansen, P.; Heylen, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Dec. 1968. 69p. (ETR-231). Dep. CFSTI (U. S. Sales Only).

Experimental data are presented on the simultaneous distribution of nitric acid and uranyl nitrate between aqueous solutions and undiluted tributyl phosphate at 24°C. The densities of the aqueous and organic phases were determined and the volume changes of the two phases after the equilibrations were measured. The experimental procedures are described and the results obtained are presented in the form of tables and graphs. (auth)

2269 (ORNL-TM-2756) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, June 1–September 30, 1969. Arnold, W. D.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). Oct. 30, 1969. 16p. Dep. CFSTI.

The ^{125}Sb contamination of cement copper increased as the liquor pH during cementation was increased. Most of the ^{125}Sb dissolved when the contaminated cement copper subsequently was dissolved in dilute sulfuric acid. The copper and antimony were separated efficiently during electrolytic deposition of copper from the solution; the ^{125}Sb count rate in the cathode copper was barely above background. When Green River oil shale was heated with tritiated water vapor at 85°C and at pressures ranging from 50 to 860 psig, the tritium contamination of the oil subsequently retorted from the shale increased with increase in shale exposure. In tests at 560 psig, the tritium content of oil increased by 35% as the shale exposure time was increased from 1 to 26 days. About half the tritium was removed from a sample of contaminated shale by heating it for 24 hr at 110°C under reduced pressure. In small-scale tests simulating operations at a natural gas processing plant, no significant exchange between tritiated hydrogen and kerosene was detected after 26 days exposure at room temperature and 900 psig. Final assembly of the equipment for measuring the radioactive constituents of natural gas samples is being made. (auth)

2270 POTASSIUM AND ^{137}Cs DESORPTION FROM SOILS. Benes, Jaroslav (Inst. of Nuclear Research, Prague); Panyr, Milos. Jad. Energ., 15: 299-302(1969). (In Czech).

The 11 methods recommended for potassium extract preparation from soils were compared and the results were used in ^{137}Cs desorption. The desorption effects of hydrochloric acid and ammonium acetate for ^{137}Cs were compared in relation to the ratio of extracting agent to soil. The conditions for ^{137}Cs and K determinations in soils were discussed. (auth)

2271 TREATMENT OF RADIOACTIVE WASTE REGENERANT OF ION EXCHANGE RESIN BY PREFERENTIAL FLOTATION METHOD. Koyanaka, Yoshio (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 6: 607-8(Oct, 1969).

An attempt was made to apply the preferential flotation method to the treatment of radioactive waste regenerants of the ion exchange resin used for purifying the primary cooling water of a light water-moderated research reactor. The overall percentage of removal was above 99% for ^{137}Cs and above 95% for the gross beta activity. (M.C.G.)

2272 LANTHANUM SOLVENT EXTRACTION MECHANISMS USING DI-(2-ETHYLHEXYL) PHOSPHORIC ACID. Kosin-

ski, F. E.; Bostian, H. (Univ. of Mississippi, University). J. Inorg. Nucl. Chem., 31: 3623-31(Nov. 1969).

The equilibrium extraction mechanism of lanthanum nitrate from aqueous solutions by purified water equilibrated bis(2-ethylhexyl) phosphate was studied at 25°C through material balance analysis of equilibrium phases. No organic diluent was used, and the lanthanum nitrate concentration in the neutral aqueous phase varied from 10 to 40 percent by weight. Equilibrium data for lanthanum distributed between bis(2-ethylhexyl) phosphate and water were obtained and used to determine complex formations and reaction stoichiometry. Infrared spectral analysis of several organic phase samples supported the material balance data and verified the movement of water molecules from the organic phase to the aqueous phase as lanthanum entered the organic layer. Three predominant extraction mechanisms involving pure lanthanum ions and partially nitrated lanthanum ions were deduced from the experimental data. (auth) (UK)

2273 WASTE PROBLEMS OF NUCLEAR POWER REACTORS. Gaudernack, Bjoern; Neset, Kjell (Institutt for Atomenergi, Kjeller, Norway). Tidsskr. Kjemi, Bergv. Met., 29: 127-34(Aug. 1969). (In Norwegian).

Radioactive wastes arising from the operation of nuclear power reactors represent a problem that is not fundamentally different from other industrial waste problems. The radioactive wastes are handled with complete control in order to ensure that they will not represent any radiation hazard to the public. The origin of the wastes, methods of treatment employed in power reactor and fuel reprocessing plants, methods of final disposal, some economic aspects, and Norwegian experience in the field are discussed. (auth) (Norway)

2274 PROBLEMS IN NUCLEAR FUEL REPROCESSING. Nippon Genshiryoku Gakkaishi, 11: 632-8(1969). (In Japanese).

A summary is presented of technical problems in nuclear fuel reprocessing, as discussed by the Special Committee on Nuclear Fuel Reprocessing during the two years from its establishment in April 1967 to its dissolution in March 1969. Problems in solvent extraction, fluoride volatility, the Aquafluor and pyrochemical processes, as well as general problems in reprocessing equipment, materials, and waste disposal are taken up. (auth)

2275 EFFECT OF F^- COMPLEXING AGENTS ON PuF_4 DISSOLUTION. Navratil, J. D. (Dow Chemical Co., Golden, Colo.). J. Inorg. Nucl. Chem., 31: 3676-80(Nov. 1969).

The effect of two types of fluoride complexing agents was investigated. The first type comprised agents forming soluble fluoride complexes, viz. Al(III), B(III), Zr(IV), and sometimes Th(IV), while the second type formed insoluble compounds, viz. Ca(II), Mg(II), and sometimes Th(IV). A survey of equilibrium constants of the various fluoride compounds was made and Ca(II), Mg(II), Th(IV) and Zr(IV) were chosen for comparison against Al(III) and B(III). According to the stability constants PuF_4 dissolution should be increased by metal ions in the order Th(IV) < Zr(IV) < Al(III) < B(III). The solubility products of the fluoride precipitates should be more negative than that of PuF_4 in order to increase dissolution of the PuF_4, and on this basis the most promising ion was Th(IV). Although Ca(II) and Mg(II) have greater Ksp values than PuF_4, both were investigated to check the validity of using these values to compare the effect of precipitating agents on dissolution. Data are tabulated for the equilibrium constants of the fluoride ion with Pu(IV), B(III), Al(III), Zr(IV), Th(IV), Ca(II), and Mg(II); also for the effect of the complexing agents on PuF_4 dissolution and amounts of Pu dissolved. It was found that the effect of complexing agent on dissolution decreased in the order B(III) > Al(III) > Ca(II) > Mg(II) > None > Th(IV). (UK)

2276 THERMODYNAMICS OF CATION EXCHANGE ON SEMICRYSTALLINE ZIRCONIUM PHOSPHATE. Nancollas, G. H.; Tilak, B. V. K. S. R. A. (State Univ. of New York, Buffalo). J. Inorg. Nucl. Chem., 31: 3643-53(Nov. 1969).

The equilibrium exchange of Li^+, K^+, and Cs^+ ions with the hydrogen form of semicrystalline zirconium phosphate at a constant ionic strength of 0.1 M in the reaction $RH + M^+ \rightleftharpoons RM + H^+$ was studied at 25°C. Solid-phase activity coefficients for the exchanging ions and free energy changes were evaluated from the ion-exchange isotherms. The enthalpies of reaction were obtained by direct calorimetric measurements and the corresponding entropy values were calculated. The thermodynamic functions were interpreted in terms of the nature of the bonding between the alkali metal ions and the matrix and the concomitant changes in hydration. (auth) (UK)

2277 RESIDUE ADSORPTION. III. MUTUAL SEPARATION OF ^{227}Ac, ^{227}Th, AND ^{223}Ra. Kirby, H. W. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. J. Inorg. Nucl. Chem., 31: 3375-85(Nov. 1969).

^{227}Ac, ^{227}Th, and ^{223}Ra can be separated from each other with good yield and radiochemical purity by adsorption on platinum followed by selective desorption. The three nuclides are deposited on Pt by evaporation from aqueous HF, HNO_3, or NH_4NO_3 solutions. The ^{223}Ra is only partially soluble in H_2O but can be quantitatively desorbed by dilute mineral acids or their ammonium salt solutions. Desorption with 0.01 N HF is preferred because it has the least tendency to disturb the ^{227}Ac and ^{227}Th fluorides in the residue. A fluoride residue containing ^{227}Ac and ^{227}Th can be leached repeatedly with 0.01 N HF to recover ^{223}Ra; however, because of alpha recoil, about half of the ingrown ^{223}Ra cannot be desorbed with dilute HF. Evidence is presented indicating that metathesis of the fluoride residue converts the Ac(III) to a double salt with ammonium nitrate. Elimination of the NH_4NO_3 by sublimation yields a basic ^{227}Ac nitrate which can be desorbed by 0.1 N NH_4NO_3 but not by H_2O. Under the conditions described, ^{227}Th remains adsorbed as an oxide or basic nitrate, while ^{227}Ac is quantitatively desorbed. (auth) (UK)

2278 SEPARATION OF CARRIER-FREE ^{90}Y FROM ^{90}Sr BY CATION EXCHANGE IN A METHANOL–AMMONIUM ACETATE MEDIUM. Kawashima, T. (Government Industrial Research Inst., Nagoya, Japan). Int. J. Appl. Radiat. Isotop., 20: 806-8(Nov. 1969).

It is stated that in the normal cation exchange method for the separation of ^{90}Y and ^{90}Sr the pH must be adjusted when preparing an eluant, although no tedious after-treatment of the effluent is required, since the ammonium acetate in the effluent is easily decomposed to ammonia and acetic acid when heated in the presence of acetic acid. The method would be more convenient if the eluant could be prepared without a pH adjustment. If the separation is carried out using only ammonium acetate as eluant, contamination of the ^{90}Y fraction with ^{90}Sr will occur because of the small difference in the distribution coefficients of Sr and Y. In the studies described these difficulties are overcome by addition of an organic solvent (methanol) and an easy and excellent ion exchange separation method is developed. Tests were also made with ethanol and acetone. Advantages of the method are stated to be: no eluant pH adjustment is necessary; only a small volume of eluant is required; the ammonium acetate effluent is easily decomposed by heating and no residue remains; highly pure ^{90}Y is obtained; the ^{90}Y can be repeatedly "milked" with a comparatively short column. (UK)

2279 ELDORADO'S PORT HOPE REFINERY: 1969. Berry, R. M. (Eldorado Nuclear Ltd., Port Hope, Ont.). Can. Mining Met. Bull., 62: 1093-9(Oct. 1969).

A brief outline of refining methods used to upgrade yellowcake to nuclear purity and to convert the uranium to the chemical and physical forms required by the fuel fabricators is presented. The uranium hexafluoride (UF_6) production facility now under construction at Eldorado, Port Hope, is discussed. Technological improvements in uranium refining are considered. (auth) (CANADA)

2280 SEPARATION OF NIOBIUM(V) AND TITANIUM(IV) BY EXTRACTION WITH AMINES FROM HYDROCHLORIC ACID SOLUTIONS. Alimarin, I. P.; Ivanov, N. A.; Gibalo, I. M. (Moscow State Univ.). Zh. Anal. Khim., 24: 1521-3(Oct. 1969). (In Russian).

Solvent extraction of niobium(V) and titanium(IV) from hydrochloric acid solutions using TOA (trioctylamine) and TAKA (~70% of trialkylamines and ~30% dialkylamines with a long chain) solutions in carbon tetrachloride was studied. It was found that niobium chloride complexes are extracted at the lower HCl concentration (3 to 8M); titanium chloride complexes are not extracted under these conditions; 15 to 20% of titanium chloride complexes are extracted from 11M HCl. A method was developed for extracting niobium and titanium at any ratios from 8.4 to 8.6M HCl using 0.1 to 0.2M solutions of TOA and TAKA. (auth)

2281 INVESTIGATIONS ON THE CHEMICAL DECOMPOSITION OF SPHERICAL FUEL ELEMENTS BY BROMINE VAPOR. Gat, U.; Hoerbe, R. (Institut fuer Chemische Technologie, Juelich, Ger.). Atomkernenergie, 14: 400-2(Nov.-Dec. 1969). (In German).

Experimental disintegration of graphite fuel spheres, and separation of the coated particles in them, by means of bromine vapor are described. According to the results obtained and those reported previously it seems possible to use the procedure by remote control in a hot cell. The optimal reaction temperature of about 140°C (80 to 170°C) and the 250°C necessary for dissociation and almost complete recovery of the bromine are relatively low. The required time of about one to two hours is reasonable. After careful milling the coated particles and coal dross are easily separated by wind sifting. The coal dross is burned. Slag and coated particles can be treated in common way for fuel reprocessing. Corrosion tests

showed nickel to be a suitable metallic construction material. (auth)

2282 STUDY OF NITRATE AND SULPHATE COMPLEXES OF URANIUM(IV). Rao, C. L.; Pai, S. A. (Bhabha Atomic Research Centre, Bombay). Radiochim. Acta,, 12: 135-40(Oct. 1969).

The extraction of uranium(IV) from nitric acid and sulfuric acid solutions at an ionic strength of 3.8 and an acidity of 1M with benzene solutions of TBP as well as TTA was studied. The stability constants for the nitrate and sulfate complexes of uranium(IV) were calculated by various methods and reported. (auth)

2283 SOME QUANTITATIVE RELATIONS ON THE RADIOACTIVE MINERALS LEACHING PROCESSES. Bunus, F.; Matei, I.; Matyas, C.; Neciu, S.; Sporea, V.; Tataru, S. (Ministry of Mines, Bucharest). Rev. Roum. Chim., 14: 729-36(June 1969).

An experimental work concerning the uranium leaching processes in view of finding the most suitable leaching conditions, was carried out. The grain size, the S/L ratio, reagent concentration, oxidant contribution, time interval, etc., were determined and some surface adsorption phenomena leading to some unexpected behavior concerning uranium dissolution were found. The solution purity was considered and the final conclusions were drawn. (auth)

2284 ESTIMATION OF EQUILIBRIUM STAGES OF ION EXCHANGE FIXED BED. Gondo, Shinichiro; Kusunoki, Koichiro (Kyushu Univ., Fukuoka). J. Nucl. Sci. Technol. (Tokyo), 6: 567-72(Oct. 1969).

A method for estimating the requisite number of equilibrium stages for an ion exchange fixed bed is proposed, and a description is given on the application of the method to systems of Na^+-H^+ and $Ca^{++}-H^+$ exchange using Amberlite IR-120. It is found that the number of equilibrium stages depends on the ion exchange system, on the concentration of the liquid phase and on the liquid flow rate. The method proposed is proved valid through comparisons between the values of H.E.T.P. based on the number of equilibrium stages thus obtained and those of H.T.U. obtained independently of N. (auth)

2285 STUDY OF THE MIGRATION OF RADIOELEMENTS IN A TUBE WITH A TEMPERATURE GRADIENT. Merinis, Jean; Bouissieres, Georges (Institut de Physique Nucleaire, Orsay, France). Radiochim. Acta, 12: 140-52(Oct. 1969). (In French).

A method for the separation of radioelements is described. The method is based on the volatilization and entrainment by a carrier gas stream in a quartz tube with a temperature gradient along the tube. A law of migration in the tube was theoretically established and experimentally proven. The method was applied to the separation of different radioelements. (auth)

2286 THE TRACER CHEMISTRY OF TRIVALENT MENDELEVIUM WITH DI-(2-ETHYLHEXYL)ORTHOPHOSPHORIC ACID. Horwitz, E. P.; Bloomquist, C. A. A. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett., 5: 753-9(Sept. 1969).

Approximately 10^5 atoms of ^{256}Md were obtained from microgram quantities of ^{253}Es. Some extraction chromatography experiments with Md(III) using di-(2-ethylhexyl)orthophosphoric acid (HDEHP) adsorbed on Celite are described. Details are given on the HDEHP selectivity of some lanthanide(III) and transplutonium(III) ions on the inert support at 25°C; also on the elution of Es(III), Fm(III), and Md(III) with 0.98M HNO_3 from HDEHP on Celite. (UK)

2287 EQUILIBRIUM CONSTANTS FOR AQUEOUS FLUORO COMPLEXES OF SCANDIUM, YTTRIUM, AMERICIUM(III) AND CURIUM(III) BY EXTRACTION INTO DI-2-ETHYLHEXYL PHOSPHORIC ACID. Aziz, A.; Lyle, S. J. (Univ. of Kent, Canterbury, Eng.). J. Inorg. Nucl. Chem., 31: 3471-80(Nov. 1969).

From studies of the extraction of yttrium, americium(III), and curium(III) from aqueous fluoride into di-2-ethylhexyl phosphate, H_2D_2, it was deduced that for $[F^-] = (0.1 - 4.0) \times 10^{-3}$ ml^{-1} and pH = 3.60 substances other than $M(HD_2)_3$ contribute appreciably to the metal, ion distribution. From known equilibrium constants for aqueous fluoro complexes of yttrium it was concluded that, under the prevailing experimental conditions, a substance of the form $YF_3 \cdot 3H_xD_x$ (where x is an unknown integer) also extracts. A method was evolved whereby distribution data alone were made to yield equilibrium constants for the stepwise formation of the first three complexes for americium(III) [$\beta_1 = 2.46 \times 10^3$, $\beta_2 = 1.28 \times 10^6$, $\beta_3 = 1.0 \times 10^8$] and curium(III) [$\beta_1 = 2.21 \times 10^3$, $\beta_2 = 1.50 \times 10^6$, $\beta_3 = 1.2 \times 10^8$] at $\mu = 0.500$ ($NaClO_4$). For $[F^-] = (0.2 - 220) \times 10^{-3}$ ml^{-1} and pH 2.50 scandium extracts overwhelmingly as $Sc(HD_2)_3$ and $\beta_1 - \beta_1$ are obtained in good agreement with published values. Tests that throw light on the nature and number of the principal metal species that extract are described. (auth) (UK)

2288 CONCERNING THE EXTRACTION OF URANIUM(VI) FROM AQUEOUS SOLUTIONS OF HF + $H_2C_2O_4$ WITH TRIOCTYLAMINE. Lipovskii, A. A.; Nikitina, S. A. Zh. Neorg. Khim., 14: 2162-7(Aug. 1969). (In Russian).

Measurements of absorption spectra and analysis of organic solutions established that on extraction of uranium from acid solutions, the compounds $(TOAH)_3UO_2Ox_2F$ and $(TOAH)_3UO_2OxF_3$ are formed. On saturation by uranium, the organic solution contains uranyl oxalatofluoride compounds. (tr-auth)

2289 MECHANISM OF DISSOLUTION OF MOLYBDENUM TRIOXIDE IN NITRIC ACID. Davydov, I. P.; Shilin, I. V. Zh. Neorg. Khim., 14: 2171-3(Aug. 1969). (In Russian).

On the basis of experimental data for the solubility of molybdenum trioxide in nitric acid, a mechanism for its dissolution is proposed. Calculated and experimental values for solubility coincided. It was confirmed that Mo^{6+} in acid solutions has the form of the molybdenyl ion. (tr-auth)

2290 REACTIONS OF RARE EARTH OXYCHLORIDES WITH THEIR CHLORIDES IN MELTS. Fam Ngok T'en; Morozov, I. S. Zh. Neorg. Khim., 14: 2246-52(Aug. 1969). (In Russian).

The reactions of chlorides of neodymium and yttrium with their oxides and oxychlorides in melts were studied. Phase diagrams were constructed for the systems $NdCl_3-Nd_2O_3$, $NdCl_3-NdOCl$, $YCl_3-Y_2O_3$, and YCl_3-YOCl. Experiments were carried out to study the reactions of oxygen in air with melts of cerium and neodymium chlorides and cerium and yttrium chlorides. The possibility of the fractional isolation of cerium from chloride melts is shown. (tr-auth)

2291 THE SORPTION OF NIOBIUM ON SILICA GEL FROM MIXED SOLUTIONS OF HYDROCHLORIC ACID-DIOXANE. Caletka, R. (Nuclear Research Inst., Rez, Czech.). Radiochem. Radioanal. Lett., 2: 139-45(Nov. 20, 1969).

The highly specific sequestering effect of dioxane on niobium was found by means of sorption on silica gel. The effect of acid and dioxane concentrations, as well as the purity of dioxane and age of niobium solutions were investigated. The column separation of ^{95}Zr and ^{95}Nb was also tested under optimum conditions. (auth)

2292 PILOT PLANT STUDIES OF METHYL IODIDE CLEANUP BY SPRAYS. Parsly, L. F. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol., 8: 13-22(Jan. 1970).

The removal of methyl iodide from containment atmospheres by reactive sprays proceeds by a simultaneous process of absorption and chemical reaction. A theoretical development is presented to show how the relative values of reaction time and other time constants of the system determine the rate-controlling process. Theoretical predictions are compared with the results of 12 experiments. For the fast-reaction case (when the reaction time is equal to or less than the fall time of the drops), the calculated removal half-times averaged 2.25 times the observed. The reasons for the difference are identified and appear to be due to erroneous equilibrium data, neglect of internal circulation in the calculation and neglect of wall effects. A reduction factor of at least 2.0 in the two-hr dose due to methyl iodide appears readily attainable. (auth)

2293 SIMULTANEOUS ELECTROLYTIC CUTTING AND LIXIVIATION HEAD-END PROCESS STEP FOR NUCLEAR FUEL REPROCESSING. Van Impe, J. (ENI-L'Electro-Navale et Industrielle S. A., Aartselaar, Belgium); Rombaux, J. P.; Chaussonnet, P. Nucl. Appl. Technol., 7: 529-36(Dec. 1969).

A new head-end process step and feasibility study of the process for an operating reprocessing plant, consisting of the electrolytic-disassembly-cutting-and-simultaneous-lixiviation of metal clad oxide power reactor fuels, has been developed and its potential as a fuel head-end reprocessing step for stainless steel and Zircaloy-clad oxide fuels was evaluated. The electrolytic cutting and simultaneous lixiviation is realized by the penetration into each of the fuel rods of the assembly, of a layer of hollow insulated metallic needles by anodic dissolution of a small slit of the fuel cladding by the electrolyte under high pressure, which by its action simultaneously lixiviates the oxide from the fuel rods; the fuel assembly acts as the anode and the needle layer as the cathode. (auth)

2294 CESIUM PURIFICATION BY ZEOLITE ION EXCHANGE. Mercer, B. W. (Battelle-Northwest, Richland, Wash.); Ames, L. L.; Smith, P. W. Nucl. Appl. Technol., 8: 62-9(Jan. 1970).

The purification of cesium by ion exchange with a synthetic aluminosilicate zeolite was demonstrated on a laboratory scale for use in preparing exceptionally pure ^{137}Cs radiation sources. Cesium ions are preferentially loaded on a column of granular Zeolon from a solution that contains Na^+, K^+, and Rb^+ impurities. The impurities are eluted from the column with a dilute ammonium carbonate scrub solution, which also elutes a small amount of the cesium during the latter part of the scrub cycle. To minimize the cesium waste loss, the latter portion of the scrub is recycled to the column ahead of the next batch of feed. The cesium remaining on the Zeolon column is eluted with a concentrated ammonium carbonate solution. The ammonium carbonate eluant is evaporated to yield a cesium carbonate which contains less than one percent total metal ion impurities. Cesium waste losses were also less than one percent. (auth)

2295 SEPARATION OF RARE EARTH ELEMENTS BY GAS CHROMATOGRAPHY OF THEIR CHLORIDES. Zvarova, T. S.; Zvara, I. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Chromatogr., 44: 604-8(Nov. 11, 1969).

Gas–solid chromatography separations of lanthanide chlorides were carried out on the glass capillary columns at ≤250° using aluminum trichloride vapors (40 to 170 mm Hg) as a component of the carrier gas. $AlCl_3$ forms volatile complexes with rare earth chlorides, and at the same time, modifies the surface of the column. (auth)

2296 DECLADDING OF NUCLEAR FUEL BY ROLLING-STRAIGHTENER TECHNIQUE. Abdel-Rassoul, A. A.; Higgy, H. R.; Hammad, F. H. (Atomic Energy Establishment, Cairo). J. Nucl. Energy, 23: 551-8(1969).

Decladding cylindrical nuclear fuel by the rolling-straightener technique was investigated. A generalized explicit equation was derived to calculate expected radial deformation Δr, based on the nature and dimensions of clad, cladded fuel material, mechanical data of the working machine, and relevant operational conditions. A linear double logarithmic function between Δr and thickness t of clad material exists. Deviation from linearity occurs as t increases to be comparable to the outer diameter of cladded fuel. The validity of theoretical deductions was experimentally verified and various factors affecting Δr are discussed. The method could be widely applied for nuclear fuel cladded with various materials such as aluminum, stainless steel, Zircaloy-2 and -4, and Inconel-702. (auth) (UK)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 2137, 2163, 2266, 2273, 2317, 2322, 2333, 2507, 2509–2512, 2523, 2649, 2654, and 3212.

2297 (COO–414-11) INFLUENCE OF SOME ORGANIC COMPOUNDS ON THE MOVEMENT OF ^{90}Sr IN SOILS. Himes, F. L.; Shufeldt, R. (Ohio Agricultural Research and Development Center, Wooster). July 29, 1969. Contract AT(11-1)-414. 14p. (CONF-690918–2). Dep. CFSTI.

From Conference on Radioecology, Cadarache, France.

The leachates of undisturbed Canfield soil in lysimeters contain some ^{90}Sr. The influences of organic compounds and of soil organic matter on the movement of ^{90}Sr have been studied. The decreasing order of effectiveness of organic compounds on the quantity of ^{90}Sr adsorbed by most soil samples is: phytic acid, glucuronic acid, citric acid, pectic acid, pyrocatechol, glycine, and dextrose. The adsorption of ^{90}Sr by soil samples after treatment with dilute HF could be altered by methylation. Methylation of soil organic matter with diazomethane decreased the quantities of exchangeable and chelated Sr fractions proportionally more than the non-displaceable fraction. Methylation with CH_3OH-BF_3 decreased only the non-displaceable fraction. In general, the quantity of water soluble Sr was greater for soil samples that had been oven-dried than for samples kept continuously moist. (auth)

2298 (USGS–474-32) PRELIMINARY LITHOLOGIC LOG OF DRILL HOLE UAe-7c FROM 0 TO 7,495 FEET (T.D.), AMCHITKA ISLAND, ALASKA. Amchitka-14. Snyder, R. P. (Geological Survey, Denver, Colo.). June 1969. 5p. Dep. CFSTI.

Includes Chart.

Drill hole UAe-7c on Amchitka Island, Alaska, penetrated at least 180 feet of volcanic breccias of the Chitka Point Formation and 7,315 feet of an alteration aureole or contact zone of a large intrusive body. This aureole consists of hydrothermally altered andesites, metamorphosed breccias, hornfels and intrusive diorites. Correlation of specific rock units from one drill hole to another at this site or between site E and other sites on the island will probably be impossible. (auth)

2299 (USGS–474-54) PRELIMINARY LITHOLOGIC LOG OF DRILL HOLE UAe-6c FROM 0 TO 6,999 FEET, AMCHITKA ISLAND, ALASKA. Morris, Robert H. (Geological Survey, Denver, Colo.). Sept. 1969. Contract AT(29-1)-474. 4p. Dep. CFSTI.

Drill hole UAe-6c, located at site D, was drilled to a total depth of 6,999 feet. The major rock types penetrated are volcanic breccia and basalt, andesite, and aplite intrusives. (auth)

2300 NEW DATINGS BY RADIOCARBON OF LATE-QUATERNARY DEPOSITS. REPORT 6. Vinogradov, A. P.; Devirts, A. L.; Dobkina, E. I.; Markova, N. G. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 10, 1171–8(Oct. 1969). (In Russian).

New results of absolute age determination of geological and archeological material by ^{14}C are given. All dates were obtained by counting the activity of ^{14}C in the form of carbon dioxide being introduced into the counter. The method of obtaining a new counting gas, propane, is described. It may be used for widening the age scale. Along with organic material a dating of carbonates (shells of molluscs) from the same sediments on the Spitsbergen has been carried out and good agreement has been obtained. The material to be dated is divided in the following manner: recent soils of the European part of the USSR and Siberia; old soils of upper-pleistocene camp sites from extraglacial regions of the Russian plain center; peat bogs of the Western Siberia; organic and carbonate material from the Spitsbergen; and single and archeological samples. (auth)

2301 COMPOSITIONAL ANALYSES OF SOILS, FORAGES, AND CATTLE TISSUES FROM BEEF-PRODUCING AREAS OF EASTERN PANAMA. Blue, W. G.; Ammerman, C. B.; Loaiza, J. M.; Gamble, J. F. (Univ. of Florida, Gainesville). Bioscience, 19: 616–18(July 1969).

A detailed study of the beef industry in Eastern Panama was made in connection with assessment of the implication of fallout in various ecosystems in relation to use of nuclear explosives for excavation of a sea-level canal. Surface soils and forage samples were collected from ranches in the general vicinity of the proposed canal route in Panama. Tissue samples were obtained from animals that had been raised in western Panama. The grasses assayed were jaragua (Hyparrhenia rufa), guinea (Panicum maximum), para (Panicum purpurascens), and pangola (Digitaria decumbens). They were analyzed for N, P, K, Ca, Mg, Sr, Zn, Mn, Fe, and Cs. The results are tabulated. The Ca content of the grass forage ranged from 0.20 to 0.40% and Mg from 0.10 to 0.30%. Strontium concentrations ranged from 14 to 100 ppM and Cs levels were not detectable at the lower limit of detection (12 ppM). The concentrations of the following elements in the liver, kidney, heart, spleen, muscle, and bone of cattle are tabulated: P, K, Na, Ca, Mg, Fe, Cu, Zn, Mn, and Sr. (BBB)

2302 RESOLVING TIME, MASS ABSORPTION COEFFICIENT, AND WATER CONTENT WITH GAMMA-RAY ATTENUATION. Fritton, D. D. Ames Lab., Iowa). Contract AT(11-1)-1269. Soil Sci. Soc. Amer., Proc., 33: 651-5(Sept.-Oct. 1969). (COO–1269-17).

A method is described that was used to experimentally determine an intensity correction for gamma attenuation. The correction is determined by using the minute nonlinearity of a semilog plot of gamma intensity versus the thickness or the product of thickness and density of a material. The experimentally determined correction is expressed in terms of resolving time and varied with both material and counting rate. A correction of 5.0 μsec/count was determined experimentally as the best resolving time to correct the observed counting rates for water content determination. Part of the 5.0 μsec/count correction was evidently due to causes other than resolving time. Mass absorption coefficients of water and soil were 0.08105 and 0.07309 cm^2/g, respectively, with no correction and were 0.0871 and 0.0773 cm^2/g with a 5.0 μsec/count correction. The difference between gravimetric water content and gamma water content dropped from 3.02% to 0.60% when this correction was used. (auth)

2303 RADIOCARBON CHRONOLOGY OF THE FLORIDA EVERGLADES PEAT. McDowell, L. L.; Stephens, J. C.; Stewart, E. H. Soil Sci. Soc. Amer., Proc., 33: 743-5(Sept.-Oct. 1969).

Radiocarbon measurements on two peat profiles near Belle Glade, Fla., indicate that peat formation in the Upper Everglades began during late Hypsithermal time, about 4,400 years B.P. (before present). Initially, peat development was very slow. About 500 to 1,000 years were required to build up the 7.6 cm of basal mucky peat, composed of a mixture of marl and organic matter. Then about 3,500 to 4,000 years ago, as a result of environmental changes, plant growths increased rapidly and were preserved as fibrous peats with very little mineral admixture. This rapid development of peat is contemporaneous with a rapid eustatic rise in sea level. Peat development proceeded rapidly (about 7.3 cm/century) from about 3,500 years to 1,200 years B.P. During this interim the existing peat, measuring about 1.37 m in thickness, was developed. By A.D. 1914 the peat had developed to a depth of about 3.65 m. This represents an average peat development of about 8.4 cm/century (4,400 B.P. to A.D. 1914). The Everglades Basin, prior to the initiation of drainage programs in the early 1900's, was inundated for a large part of the year. Since drainage, over a period of 50 years, about 1.8 m, or one-half, of the original profile has been destroyed by the prevailing aerobic conditions. (auth)

2304 RADIOISOTOPES IN WATERS OF NEOVOLCANIC REGIONS OF THE CAUCASUS. Kuptsov, V. M.; Cherdyntsev, V. V.; Zverev, V. L. (Geological Inst., Moscow). Geokhimiya, No. 9, 1153-5(Sept. 1969). (In Russian).

Data are presented on the content and isotopic ratios of uranium (^{235}U and ^{234}U), of thorium (^{232}Th, ^{230}Th, and ^{228}Th), and of radium (^{226}Ra and ^{228}Ra) in typical volcanic waters. The uranium content was normal with an average value of about 4×10^{-7} g/l. The isotopic ratio with an average of about two for uranium and of about seven for thorium was significantly higher than for volcanic waters. The ratio of ionium to thorium was small (less than one on the average). The low actinium content may be due to slight accumulation of the parent protoactinium. The thorium/uranium ratio was normal. The radium content was very small (from 1×10^{-15} to 2.3×10^{-14} g/l), and was significantly below the equilibrium content from uranium. The Ra/U ratio in some cases was only 1.2×10^{-3} (in activity units), and was never greater than 0.43. The radon content was low (from 4×10^{-13} to 2.9×10^{-11} Ci/l). The uranium/radon ratio was very high. It was not lower than 3.3×10^{-3}, and in some cases it was even larger than the equilibrium amount of radon (U/Rn = 1.25). (TTT)

2305 SOME DESIGN CRITERIA FOR GAMMA BACK SCATTER SOIL DENSITY GAUGES. Lin, K.; Taylor, D.; Pirie, E. (Univ. of Strathclyde, Eng.). Soil Sci., 108: 300-2(Oct. 1969).

The counting rate vs density characteristic of a gamma backscatter gauge exhibits a peak counting rate at some specific density ($\rho_m \times d = n/\bar{\mu}$ where n is a numerical constant decided by the build-up factor and $\bar{\mu}$ is the mean value of the mass absorption coefficient at the gamma-energy (E) concerned. The original measurements were carried out with a cesium-137 source for which E = 0.66 MeV, and the product $\rho_m \times d$ in this case is of the order of 16. The position of the counting rate maxima, corresponding to ρ_m can be adjusted by a choice of d to provide any required range of density measurements. The equation shows that it provides a satisfactory method for the designer of soil density gauges to decide on the best geometry to meet a particular need. (J.C.W.)

2306 GROUNDWATER STUDIES IN THE SABI VALLEY, RHODESIA, USING NATURAL TRITIUM MEASUREMENTS. Wurzel, P. (Ministry of Water Development, Salisbury, Rhodesia); Ward, P. R. B. J. Hydrol., 8: 48-58(May 1969).

The use of natural tritium in groundwater studies was investigated. The atmospheric injection of tritium into groundwater systems provides a unique tracer method to give information of movement on a regional scale. The rise of the tritium content of southern hemisphere rainfall, starting in 1960 and 61 due to hydrogen bomb tests, has provided a series of input pulses. Single stage electrolysis was used to raise the tritium concentration of water samples by ~10 times. The enriched sample was then reduced to hydrogen gas which was combined with tritium-free ethylene to form ethane. The ethane gas was counted in a gas proportional counter at 2 atm pressure. In spite of enrichment, natural tritium counting required a gas proportional counter of very low background. A counter was used which incorporated the main counter and an anti-coincidence counter in the same pressure shell. Using a counter sensitivity of 1 cpm equivalent to 90 T.U. and choosing 2 standard deviations (i.e., 0.24 cpm) as the limit of significance, 20 T.U. was obtained as the minimum detectable amount of tritium in an unenriched sample. This lower limit improved in proportion to the enrichment factor and at 14 times enrichment it was possible to detect 1.5 tritium units. Measurements were made of tritium in groundwater in the Sabi Valley Alluvial plane in Rhodesia, and flow data were thus obtained on a regional scale. It was found that the groundwater movement was closely approximated by piston type flow and the tritium content in boreholes was related to tritium input in 2 areas of recharge. The results indicated that Sabi River plays a greater role in the groundwater regime of the alluvial plain than originally anticipated. Velocity of movement of the groundwater was deduced as 2 to 5 ft/day. (BBB)

2307 USING RADIOACTIVE ISOTOPES IN HYDROLOGY. VII. MEASURING SMALL FILTER VELOCITIES BY THE POINT DILUTION METHOD. Klotz, Dietmar; Moser, Heribert (Institut fuer Radiohydrometrie, Munich). Atomkernenergie, 14: 423-30(Nov.-Dec. 1969). (In German).

The measurement of small filter velocities (yields) in a groundwater current is of special hydrological interest. Therefore the point dilution method employed to measure filter velocities in a single borehole with the aid of radioactive tracers has been tested on filter velocities ranging below 0.3 m/day. In addition to the influence on the measuring process of the mixing and concentration of the tracer within the measuring volume, investigations covered diffusion phenomena and convection as well as osmotic effects resulting in a dilution of the tracer solution. From the results, working instructions for field measurements have been derived. (auth)

2308 THORIUM MOVEMENTS IN MORAINAL SOILS OF THE HIGH SIERRA, CALIFORNIA. Hansen, Richard O.; Huntington, Gordon L. (Univ. of California, Davis). Soil Sci., 108: 257-65(Oct. 1969).

Thorium distributions in a sequence of morainal soils in Bench Valley, California, were determined by gamma spectrometry of profile samples. Concentrations of thorium ranged from 10.8 ppM in a B2h horizon, to 24.0 ppM in a B2ir horizon. The data indicate distinct thorium accumulation in horizons immediately underlying horizons of high organic content. A2 or B2ir horizons respectively contained higher thorium concentrations when overlain by A1 or B2h horizons. Soil organic matter apparently complexed with thorium as well as with iron, although the leached iron accumulated visibly in horizons of pH 5.5 or greater, whereas thorium distributions were more diffuse and apparently less affected by change in pH. Radium was distributed (0.85 to 1.91 picograms/g) more irregularly than was thorium reflecting the effects of the soil chemistry of ^{238}U, ^{234}U, ^{230}Th, as well as ^{226}Ra, with the passage of time. Radium distributions are explained in terms of uranium retention by organic matter, mobilization of ^{230}Th by organic matter, plant absorption of radium, and time. Potassium concentrations ranged from 1.9 to 4.8 percent, being generally higher in A2 horizons than in A1 horizons. (J.C.W.)

2309 ENGINEERING GEOLOGY NEAR THE SITE OF THE ATOMIC POWER STATION AT TSURUGA. I. Nasu, Nobuji (Waseda Univ., Tokyo). Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 43, 1-9(Feb. 1969).

The second atomic power station of Japan Atomic Power Company, Ltd. is situated about 40 km southwest of Fukui City, in the northeastern part of the Tsuruga Peninsula which protrudes into Wakasa Bay; the site is 140,000 m^2 including part of plain and of mountainous area. The mountainous area which borders the site on its eastern side has a maximum height of 161 m, and trends in a direction from northwest to southeast. Geomorphological studies of the coastal area were made and three geomorphologic faults in parallel with each other were found near the site of the atomic power station. Prior to the installation of the atomic power station, close investigations were carried out on the faults, centered on whether they are active or inactive. In this connection, the following are described: faults, active and inactive; geomorphological features of Wakasa Bay; faults near the site of the reactor plant; rocks near the atomic power station; faults in trenches; other faults near Tsuruga; and main earthquakes that occurred in Wakasa Bay and near Tsuruga. (NSA of Japan)

2310 DATA. SECTION II. WATER. Radiol. Health Data Rep., 10: 359-61(Aug. 1969).

Activities of Federal, State, and local agencies in water quality sampling and analysis programs for surface, ground, and treated water are described. Standards for radioactivity levels in water supplies are discussed. Data on gross radioactivity in surface waters of the USA are presented. (R.C.K.)

2311 ALPHA-RECOIL TRACKS IN MICA: REGISTRATION EFFICIENCY. Katcoff, Seymour (Brookhaven National Lab., Upton, N. Y.). Science, 166: 382-4(Oct. 17, 1969).

Recoils from alpha-particle decay of naturally occurring radioactive nuclides have energies between 70 and 169 keV. It was found that these alpha recoils register tracks in mica, observable as etch pits, with an efficiency of about 80%. When the recoil energy is degraded to 40 keV the efficiency drops to 50%. But, since the decay of each thorium or uranium impurity atom in natural mica is followed by a cascade of six or eight alpha particles, the overall registration efficiency must be very nearly 100%. (auth)

2312 GROWTH POTENTIAL OF ISOTOPES. Smith, D. B. (Atomic Energy Research Establishment, Wantage, Eng.). S. Afr. Mining Eng. J., 80: 628-36(Mar. 21, 1969).

Advances in environmental science during the next decade will rely on the exploitation and development of isotope techniques in association with more conventional methods. In particular, the following areas should be developed: hydrology, to include low-level ^{3}H tracing of ground water, ^{14}C measurements (often in combination with natural ^{3}H), and ground water stratification; oceanography, to include coastal and off-shore sea-bed movement tracer studies, sea-bed in situ analytical techniques, and coastal water pollution; meteorology, to include tropospheric air movements on a large scale using added radioactive tracers, storm and anticyclonic isotope variations, and atmospheric pollution. The rate of expansion in these and allied fields will be governed by financial considerations, which in their turn will be increasingly influenced by economic factors such as cost/benefit considerations. The most rapid expansion will be in areas where direct economic gain is evident and where commercial rather than academic interests influence the program. (BBB) (TSS)

2313 RADIOMETRIC SURVEY WITH A CAR-MOUNTED INSTRUMENT IN THE NORTHERN PART OF ABUKUMA DISTRICT. Obi, Nakamaru; Ujiie, Akira (Geological Survey of Japan, Kawasaki). Chishitsu Chosasho Geppo, 20: 173-83 (Mar. 1969). (In Japanese).

In order to study the distribution of natural radioactivity, a radiometric survey with a car-mounted scintillation counter was carried out in the northern part of Abukuma district, Miyagi and Fukushima prefectures. The area surveyed was approximately 1,600 km^2. The detector used consists of a NaI(Tl) phosphor of 5 in. diameter and of 2 in. thick. Radioactivity of the rocks mainly distributed in this district, which is expressed by gamma intensity along the traverses, is tertiary volcanic rocks, 400 to 500 counts/sec; cretaceous granitic rocks, 500 to 900 counts/sec; and late mesozoic or early paleozoic granodiorite, 350 counts/sec. Uraniferous mineralization was in lignite seams. No radioactive anomaly was recognized along the traverses. (NSA of Japan)

2314 APPLICATION OF THE IMPULSE NEUTRON–NEUTRON METHOD IN THE OIL INDUSTRY OF TATARIA. Kildaeya, F. F. Petrol. Geol. (USSR) (Engl. Transl.), 8: 123-9(June 1969).

A method for determining the position of the water-oil contact is described. The method, impulse neutron-neutron logging (INNK), uses a neutron generator which provides a flux from the accelerator tube of about 2×10^6 n/sec. The energy of the electrons emitted as a result of the deuterium–tritium nuclear reaction is equal to 14.3 MeV and the frequency of secondary neutron impulses is 400 Hz. The target (indicator) of the thermal neutrons is located 40 cm from the source. The length of the borehole instrument is 3 m, and the diameter is 102 mm. The total of 61 wells was investigated in the Aznakayev, Pavlov, and Zelenogorsk areas of the Romashkino and Bavly fields. The measurements were carried out at points every 0.5 to 1.0 m along the shaft of the well. The parameter studied was the ratio of the differential calculation to the integral calculation; therefore, errors in the measurements connected with unstable discharge of neutrons are at a minimum. At a given position in the water-oil contact zone the difference in indexes opposite water-bearing and oil-bearing components increases with an increase in the lag time (time after entrance of fast neutrons into the stratum). The accelerator tubes used permitted measurements to be made with a time lag up to 800 to 900 μsec. To obtain more reliable information on the stratum, point measurements with impulse neutron-neutron logging were supplemented by readings on curves of the drop in density of thermal neutrons in the most reliable sectors of the stratum (interval of lag 0 to 1700 μsec). On the basis of these data, calculations were made of the numerical values of the life time of thermal neutrons in the stratum. The life time of neutrons in perforated oil-bearing strata flushed with salt water ranged from 340 to 190 μsec, and in water-bearing strata (with a sp gr of 1.18 to 1.19) from 60 to 160 μsec. In 39 wells measurements were carried out in standing, salt-water flushed, perforated wells. Measurements of density of thermal neutrons by the impulse method showed that the sensitivity and depth effectiveness of impulse neutron-neutron logging are high. Some examples of results in individual wells are presented. (BBB)

2315 ^{14}C TRENDS IN SUBFOSSIL PINE STUBS. Vogel, J. C. (Univ., Groningen, Netherlands); Casparie, W. A.; Munaut, A. V. Science; 166: 1143-5(28 Nov 1969).

Subfossil pine stubs from a peat bog in the Netherlands were linked together dendrochronologically and sampled at intervals of 30 or 50 years for carbon-14 analysis. The results suggest that the carbon-14 content of the atmosphere was not changing between about 5400 and 5100 B.C., but that it was increasing slightly about 800 years earlier. (auth)

Meteorology

Refer also to abstracts 2312, 2315, 2518, and 2656.

2316 (AECL–3289) A STUDY OF LOWER ATMOSPHERIC TEMPERATURE PROFILES AT WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT. Reimer, A.; Munn, R. E. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Jul 1969. 13p. Dep. CFSTI (U. S. Sales Only). CAN $0.50.

Tethersonde vertical temperature profiles taken at WNRE during the summers of 1965 and 1966 are examined to delineate the characteristics of a typical summertime inversion. Mean temperature difference profiles and temperature difference standard deviations and extremes for one hundred foot layers are included. The air pollution implications are briefly examined. (auth)

2317 (CONF-690705) UNIVERSITIES, NATIONAL LABORATORIES, AND MAN'S ENVIRONMENT CONFERENCE HELD JULY 27–29, 1969, CHICAGO, ILLINOIS. (Argonne Universities Association, Ill.). Nov. 1969. 167p. Dep. CFSTI.

The proceedings of a conference on the role of the national laboratories and universities in the solution of environmental problems, held in Chicago, July 27 to 29, 1969, are presented. Papers were presented on social problems and the interaction of problem solving agencies; standards for, and the control of, environmental quality; waste disposal practices; radiation protection standards; research requirements; and automobiles and air pollution. (L.C.L.)

2318 (NYO–4039-1, pp 84-98) FALLOUT STUDIES AND THEIR RELATIONSHIP TO THE GENERAL PROBLEM OF ENVIRONMENTAL RADIOCONTAMINATION. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca).

The widespread studies on radioactive fallout produced by nuclear weapons testing have provided a valuable base-line set of observations for problems that may arise as peaceful uses of atomic energy continue to expand. The ability to use known relationships and available data from fallout studies was examined from the viewpoint of assessing the radioactive environment for a specific area. In particular, the area considered involves the Finger Lakes Region of Upstate New York and the situation concerns the feasibility of locating nuclear power reactors on these lakes. (auth)

2319 (TID–25075) PLUME RISE: A CRITICAL SURVEY. Briggs, G. A. (Air Resources Atmospheric Turbulence and Diffusion Lab., Oak Ridge, Tenn.). 1969. 81p. Dep. CFSTI. For Oak Ridge National Lab., Tenn.

The mechanism of plume rise and dispersion is described in qualitative terms with emphasis on possible aerodynamic, meteorological, and topographical effects. Plume-rise observations and formulas in the literature are reviewed, and a relatively simple theoretical model is developed and compared with other models. All available data are used to test the formulas for a number of idealized cases. The inverse wind-speed relation, $\Delta h \propto u^{-1}$, is shown to be generally valid for the rise of a hot plume at a fixed distance downwind in near-neutral conditions. Nine formulas of this type are compared with data from sixteen different sources, and the best agreement is obtained from the "$^2/_3$ law," $\Delta h = 1.6F^{1/3} u^{-1} x^{2/3}$, modified by the assumption that a ceiling height is reached at a distance of ten stack heights downwind. The term F is proportional to the heat emission. In uniform stratification buoyant plumes are seen to follow the $^2/_3$ law until a ceiling height of $2.9 (F/us)^{1/4}$ is approached, where s is proportional to the potential temperature gradient. In calm conditions the formula $\Delta h = 5.0F^{1/4} s^{-1/4}$ is in excellent agreement with a wide range of data. Formulas of a similar type are recommended for nonbuoyant plumes on the basis of much more limited data. (auth)

2320 WASHOUT STUDIES OF FALLOUT PARTICLES IN THE LOWER TROPOSPHERE BETWEEN 700 AND 3000 m. Reiter, Reinhold; Carnuth, Walter (Physikalisch-Bioklimatische Forschungsstelle, Garmisch-Partenkirchen, Ger.). Arch. Meteorol., Geophys. Bioklimatol., Ser. A, 18: 111-46(1969). (In German).

Continuous, simultaneous measurements of the radioactivity from fission products in air and precipitation have been made since December, 1963, at 3 sites in the Bavarian Alps (Garmisch–Partenkirchen, 730 m; Wank summit, 1780 m; and Zugspitze peak, 2966 m). These stations are closely spaced in the horizontal and roughly equidistant in the vertical. From the data thus acquired, the capture cross-section q (m^2/l) and the fraction (f) of the activity obtained from precipitation in a layer of given thickness are computed. The relative decrement (f') of the abundance of fission products in air was also determined, and compared with (f). Thus, quantitative characteristics for the washout process are obtained and are classified with reference to the type of precipitation (rain, snow, showers, etc.). Means and frequency distribution statistics are derived from the data and compared with theoretical results and, as far as these are known, also with observational results reported by others. Furthermore, the influence of several meteorological parameters was studied. Cable car soundings were processed to obtain a quantitative estimate of the errors induced by evaporation of falling precipitation under various conditions. Possible explanations for the frequently reported decrease in precipitation activity within the melting zone are considered. By extrapolation, the height at which precipitation radioactivity would vanish if subject to linear attenuation was determined. Comparison of the result of the computations with the assumed height of the cloud tops showed that the amount of activity incorporated in falling precipitation is relatively small in relation to the fallout capture by the washout process. (BBB)

2321 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep., 10: 363-8(Aug. 1969).

Seventy-three stations in the United States, 24 in Canada, and 12 in South America monitor atmospheric radioactivity. Data collected in April 1969 on the gross beta activities in surface air and atmospheric precipitation at these stations are presented. (L.C.L.)

2322 ENVIRONMENTAL SURVEILLANCE AROUND A NUCLEAR FUEL REPROCESSING INSTALLATION, 1965–1967. Kelleher, William J. (New York State Dept. of Health, Albany). Radiol. Health Data Rep., 10: 329-39(Aug. 1969).

Environmental surveillance around a nuclear fuel reprocessing plant is reported. Data obtained before and after the plant began operations in April 1966 is included. Media monitored included air and milk supplies in the surrounding area; liquid wastes; local watersheds and streams; silt, deer, and fish in the plant perimeter area. Data obtained through 1967 indicate that the discharges from

the plant stack have not produced environmental effects from particulate beta-particle emitters or iodine-131 that might constitute a public health hazard. Surveillance of the streams showed greater concentration of strontium-90 during the fall and winter of 1966–1967 than in the latter part of 1967. Silt removed more cesium-137 than strontium-90; most of the latter was in the dissolved state. The ratio of cesium-137 to cesium-134 (cesium-134 is indicative of spent fuel) in the wastes was about 4 or 5 to 1. The levels of radioactivity in deer and fish were sufficiently high to require careful evaluation of the public health significance. (auth)

2323 AEROSOL RESEARCH IN EAST GERMANY. Idojaras, No. 4, 254-5(July-Aug. 1969).

The research program of the Wahnsdorf Air Chemistry Observatory of the East German Meteorological Service is concentrated on the problem of maintaining the purity of the air. Mass of atmospheric radioactivity, sulfur dioxide, soil ozone, and total aerosol content are measured. An electric filter (electrostatic precipitator) with which atmospheric solids can be precipitated according to size was developed. The mass of aerosols trapped by the device is sufficiently great to permit simultaneously the fractionated chemical analysis and microscopic and electron microscope examination of a single sample as well as the measurement of the radioactivity of the trapped particles. A KEM-1 electromicroscope is operating for the purpose of aerosol research. A continuously registering dust counter which operates on a photoelectric principle is under construction which will register the distribution of particles according to size and concentration. The State Radiation Protection Institute of Berlin is authorized to control all work connected with radiation protection anywhere in East Germany. It carries out that part of its duties which concern the radiation protection of the population partly through the aid of information received from the Meteorological Service. The ratio of $^{89}Sr/^{90}Sr$ in the atmosphere is measured continuously. (JPRS)

2324 STABLE ISOTOPES OF THE ATMOSPHERE. Eck, C. F. (Mound Lab., Miamisburg, Ohio). J. Chem. Educ., 46: 706-10(Nov. 1969).

The history of the discovery of components in the atmosphere is traced. There is a nonvariable and variable composition of air and the stable isotopes of air are used for low-temperature refrigerants, gas lasers, atomic projectiles, wavelength standards, tracers in medical and biological studies, and raw materials for radioisotope preparation. Isotope concentration and enrichment are also discussed. (J.C.W.)

Mineralogy and Exploration

Refer also to abstract 2523.

2325 URANIUM DISTRIBUTION IN SEDIMENTARY ROCKS FROM THE WESTERN PART OF THE OIL AND GAS BEARING BASIN IN THE AMU DARYA REGION. Alekseev, F. A.; Gottikh, R. P.; Vorobeva, V. Ya.; Muraveva, L. V. (All-Union Scientific Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). Geokhimiya, No. 10, 1238-47(Oct. 1969). (In Russian).

On the area of old sedimentary basins a zoning in uranium distribution was observed which reflects various sedimentation conditions; high uranium contents are confined to shallow coastal facies. The uranium content of rocks gradually decreases in the intermediate zone and increases towards the open sea. The adherence of rocks to some facial zones also determines the character of uranium distribution over the rock types. The study of tracks of uranium pressure indicated the presence of a distinct connection of uranium with organic matter and their simultaneous accumulation. (auth)

2326 DEVELOPMENT OF URANIUM EXPLORATION METHODS USING RADON. Dyck, W. GSC Paper 69-46. Ottawa, Dept. of Energy, Mines, and Resources, 1969. 26p. $1.50.

The results of tests carried out during the 1968 field season to determine the applicability of the radon method for detailed prospecting for uranium are described. Radon tests in surface waters and in soils were carried out in three different geological environments; the Gatineau Hills, Quebec, and Sudbury and Elliot Lake, Ontario. In the Gatineau Hills, seasonal variations, variations with depth of lake, with distance from shore, and with distance from uranium occurrence along shore, were studied. The results suggest that surface and underground water drainage is responsible for the radon and radium in the lake systems. Where the overburden is one or two feet thick on-site radon and thoron determinations in soil emanations in the Gatineau Hills outlined radioactive pegmatites somewhat more clearly than did gamma-ray tests. Although radon levels varied by a factor of two, anomalies related to source were detected throughout the field season. A radon anomaly, detected in a reconnaissance survey of the surface waters of the eastern quarter of the Sudbury irruptive, appears to be similar in origin to the anomalies investigated in the Gatineau Hills. Radon and gamma-ray levels across the copper–nickel ore borders were comparatively low and meaningless. In the Elliot Lake area the distribution of radon in four lakes was studied; two in the contaminated westward drainage channel of the southern limb of the Quirke syncline, and two in uncontaminated terrain overlying the uranium-ore-bearing Matinenda Formation. The results from the contaminated lakes demonstrate some of the principles of the radon prospecting method very well except for the fact that man, rather than nature, introduced the radium which gives rise to the high radon levels in the water system. The radon levels in the uncontaminated lakes are at least a factor of ten lower than in the contaminated lakes, and straddle the sensitivity limit of the instrument. Some shallow creek deltas are reflected in the radon profiles 50 feet from the mouth of the creek and hence could serve as starting points for regional investigations. Relative to the lakes in the Gatineau Hills, the radon levels in the two uncontaminated lakes in the Elliot Lake region are low. Regional backgrounds, rather than absolute radon levels, must therefore be employed to determine anomalies. On-site radon determinations in soil emanations across the uranium ore zone at the Rio Algom Quirke Mine outline the ore zone more distinctly than do gamma-ray determinations. Soil tests across the projected contact of the Matinenda Formation in the southern limb of the Quirke syncline gave a negative anomaly at the contact. In general the investigations have shown that depending on the medium and sampling density employed, the radon method can outline radioactive sources on a reconnaissance scale as well as on a more detailed scale. (auth)

Oceanography

Refer also to abstracts 2312, 2327, and 2668.

Seismology

2327 (AD-691248) LINEAR THEORY OF BOTTOM REFLECTIONS. Britt, James R. (Naval Ordnance Lab., White Oak, Md.). May 12, 1969. 144p. (NOLTR-69-44). CFSTI.

A detailed mathematical development is given of a linear, spherical wave theory for the reflection of underwater explosion shock waves from plane bottoms of either fluid or rigid materials. The Laplace transform method is used to obtain integral solutions for the pressure which can be evaluated numerically. Linear equations of motion are presented along with the derivation of the wave equations and solutions of the wave equations. Two methods of integrating the integral solution are discussed. First, the real part of the integral is separated from the imaginary part to allow integration using real arithmetic. Second, a method of integration using complex arithmetic is described. (auth) (USGRDR)

2328 SEISMIC ACTIVITY AND FAULTING ASSOCIATED WITH A LARGE UNDERGROUND NUCLEAR EXPLOSION. Hamilton, R. M. (Geological Survey, Menlo Park, Calif.); McKeown, F. A.; Healy, J. H. Science, 166: 601-4(Oct. 1969).

The 1.1-megaton nuclear test Benham caused movement on previously mapped faults and was followed by a sequence of small earthquakes. These effects were confined to a zone extending not more than 13 kilometers from ground zero; they are apparently related to the release of natural tectonic strain. (auth)

2329 HIGH FREQUENCY TELESEISMIC ENERGY FROM ALEUTIAN SOURCES. Bufe, C. G.; Willis, D. E. (Univ. of Michigan, Ann Arbor). Bull. Seismol. Soc. Amer.: 59: 2061-70(Oct 1969).

The Long Shot event, detonated at Amchitka in the Aleutian Islands, was recorded at three sites in Michigan at distances of 57 to 63 degrees. Analysis of the data recorded on magnetic tape shows significant high frequency (4 to 5 Hz) energy in the first compressional wave arrivals at all three stations, although the most prominent spectral peaks are in the range 1.0 to 1.6 Hz. Initial P phases of aftershocks of the Good Friday earthquake of 1964 recorded at the Ann Arbor station do not contain appreciable energy above 2 Hz. However, the P-wave spectrum of an earthquake of comparable magnitude whose epicenter is near, Long Shot is very similar to that of Long Shot, and indicates a favorable signal-to-noise ratio to 5 Hz. The Long Shot spectra and apparent angle of incidence at the Michigan stations appear to be influenced by the presence of pP and by crustal layering. The effective response of an intermediate-depth well system is shown to be strongly affected by surface reflections. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 2269, 2301, 2327–2329, and 2365.

2330 (CEA-R-3850) PHYSICS OF PHENOMENA IN THE ZONE CLOSE TO AN UNDERGROUND NUCLEAR EXPLOSION. Maury, Jacques; Levret, Clet (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Sept. 1969. 47p. (In French). Dep. CFSTI (U. S. Sales Only).

After a description of the phenomena of underground explosions, the basic laws governing the propagation in the ground of the energy produced by the explosion are given. Hydrodynamics, the mechanics of solids, the equations-of-state for solids and gases in the case of very high and medium pressures, and the dynamic strength of solids are considered. A system of equations is given which defines the changes with time of the shock wave produced in the ground by the explosion. (auth)

2331 (HN-20-210) NUCLEAR OPERATIONS PLAN FOR EXCAVATION OF A SEA LEVEL CANAL BY NUCLEAR MEANS ROUTE 17A. Perla, H. F.; Woolfenden, J. H. (Holmes and Narver, Inc., Los Angeles, Calif.). Oct. 1969. 95p. Dep. CFSTI.

The nuclear operations plans required for nuclear excavation of a sea-level canal by Route 17A in Panama are described and include: nuclear safety operations for ensuring the radiological and seismic safety of the surrounding area and its inhabitants; methods for handling nuclear explosives; personnel and facilities required for the operation; security measures necessary; and, finally, estimates of the cost of the complete nuclear operation. (L.C.L.)

2332 (HN-20-211) NUCLEAR OPERATIONS PLAN FOR EXCAVATION OF A SEA LEVEL CANAL BY NUCLEAR MEANS ROUTE 25E. Perla, H. F.; Woolfenden, J. H. (Holmes and Narver, Inc., Los Angeles, Calif.). Oct. 1969. 97p. Dep. CFSTI.

The nuclear operations plans required for nuclear excavation of a sea-level canal by Route 25E in Panama are described and include: nuclear safety operations for ensuring the radiological and seismic safety of the surrounding area and its inhabitants; methods for handling the nuclear explosives; personnel and facilities required for the operation; security measures necessary; and estimates of the cost of the complete nuclear operation. (L.C.L.)

2333 (PNE-R-8) EMPLACEMENT AND CEMENTING OF HOLE 25-95A (EMPLACEMENT HOLE) HAYWARD WELL IN GARFIELD COUNTY, COLORADO. RULISON PROJECT. (Austral Oil Co., Inc., Houston, Tex.). [nd]. 16p. Dep. CFSTI.

The casing emplacement and cementing operations on the Number 25-95 A Hayward Well in Garfield County, Colorado for the Rulison Project are reported. A string of 10¾ in. casings was placed to a total depth of 8701 ft and cemented in three stages. Cement quality was verified by the use of an acoustic bond log and a density log. The package envelope, 5.2 ft long and containing boron carbide in its annulus, was included in the 10¾ in. casing string so as to be in the Mesa Verde Section at 8442½ ft. Inside the 10¾ in. casing, the cement was drilled out to a depth of 10½ ft below centerline of the boron carbide envelope. This total depth was confirmed by wire line measurements, and a casing collar locator, to be 8453 ft. A 900 cfm air compressor was used in conjunction with gas lift valves, appropriately placed in a string of 2⅜ in. tubing, for the removal of all fluid from the 10¾ in. casing. Dryness of the casing was tested by dumping a 100 lb sack of micro-cell in the annulus between 2⅜ in tubing and 10¾ in. casing and observing the dust ejected from the "Blooie" line. Strength of the cement plug in the 10¾ in. casing, at 8453 ft, was tested by an applied load of 84,000 lb. Diameter uniformity and casing straightness were checked by running a 9 in. dia, 15 ft long mandrel to the total depth of 8453 ft. Dryness was double checked by a bailer, filled with sample sacks of micro-cel, run on sand line to 8453 ft. Smoothness of the cement top in the casing was inspected by a 9 in. dia. lead impression block with 20,000 lb applied pressure. All tests were favorable and acceptable to participating parties. (auth)

2334 (PNE-R-10) PROJECT RULISON: PLANNING DIRECTIVE. (Nevada Operations Office (AEC), Las Vegas). May 1969. 60p. Dep. CFSTI.

Planning is described for the Rulison experiment aimed at determining the potential of nuclear stimulation for commercial development of low permeability gas fields. (J.R.D.)

2335 THE DEVELOPMENT AND USE OF NUCLEAR ENERGY IN THE PEOPLE'S REPUBLIC OF CHINA. II. SOVIET ASSISTANCE AND CHINESE NUCLEAR WEAPONS DEVELOPMENT. Rifkin, Susan Beth. IRT (Int. Res. Technol.) Nucl. J., 1: No. 5, 1-13([1969]).

The role of the USSR in the development of nuclear weapons in the Peoples Republic of China (CPR) from 1950 on is assessed in terms of both its political and technical importance. Historical events which created the initial assistance, the kind of technical aid provided, and the manner in which the Soviets were able to heavily influence the direction of the Chinese nuclear program are discussed. (L.C.L.)

2336 NUCLEAR CAVITIES COULD STORE CRUDE OIL BENEATH THE SEA. Oil Gas J., 66: No. 36, 90-2(Sept. 2, 1968).

The feasibility of using nuclear explosion-produced undersea cavities for the storage of crude oil pumped from offshore drilling sites is examined in terms of the requirements for producing the undersea nuclear cavity and for transporting the crude oil into and out of the storage cavity. It is concluded that crude oil storage in undersea nuclear cavities has the advantages of low vulnerability, low hazard radius, low space requirements, low cost, and power-off handling of slow-specific gravity fuels. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 2418, 2866, 2868, 2869, 2872, and 3480.

2337 (AD-691072) ANALYTICAL STUDIES ON ION PROPULSION. Boden, R. H. (Rocketdyne, Canoga Park, Calif.). Aug. 1960. Contract AF49(638)-649. 79p. (R-2147-P; ARL-TR-60-279). CFSTI.

Analyses of major problems associated with components of the ion rocket engine system have been made. Component studies include electrical power generation systems, thermal power conversion, and accelerating electrode configurations. Analyses of ion beam dynamics, propellant materials, radiation damage to working fluid for a nuclear power plant, and missions using low-thrust vehicles are presented. Interpretation of these analyses is made in terms of engine design parameters. (auth) (USGRDR)

2338 (ANL-7562) DYNAMIC PLASTIC RESPONSE OF A TUBE TO AN IMPULSIVE RING LOAD OF ARBITRARY PULSE SHAPE. Youngdahl, Carl K. (Argonne National Lab., Ill.). Apr. 1969. Contract W-31-109-eng-38. 58p. Dep. CFSTI.

The problem of the deformation of a long, circular, cylindrical shell made of a rigid, perfectly plastic material and subjected to an impulsive ring load is solved for arbitrary pulse shapes. The principal result of the investigation is that the dynamic effect of the pulse shape is almost completely characterized by its associated impulse and effective load (defined as the impulse divided by twice the mean time of the pulse). This means that details of the pulse shape and, in particular, its peak value are comparatively unimportant in determining the history of the plastic deformation and the final shape of the shell. The implications for experimental work are encouraging, since the impulse and effective load are easily computed from a pressure-time plot and are not strongly influenced by experimental inaccuracies. (auth)

2339 (CEA-R-3910) IRRADIATIONS AT LOW TEMPERATURES: DEVICES DESIGNS. Conte, Rolland Rene (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct. 1969. 34p. (In French). Dep. CFSTI (U. S. Sales Only).

After an attempt to classify the irradiation devices, the two different refrigeration systems used, stored liquid or refrigerator, are presented. Some financial aspects of these two systems are discussed. For a long run, 1,000 hr per year (100 hr for He) the refrigerator becomes less expensive than stored liquid devices. Some ideas about the principal criteria used in the design of the device are discussed. Finally a few assumptions which facilitate the design calculations for different parts of a cryostat are given. (auth)

2340 (N-69-33273) THERMIONIC FUEL IRRADIATION EXPERIMENT DESCRIPTION. Migra, Robert P.; Kaszubinski, Leonard J.; Brown, Robert L. (National Aeronautics and Space

Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1969. 48p. (NASA-TM-X-1858). CFSTI.

An instrumented lead-type experiment for the irradiation of encapsulated fuel and insulator specimens at temperatures and fast neutron fluxes that simulate thermionic reactor conditions is described. Fast neutron fluxes are obtained by use of a cadmium and boron carbide shield to remove the thermal neutrons and a portion of the epithermal neutrons. Automatic temperature control of the fuel is obtained by varying a mixture of argon and helium gas in a thin annulus between the primary and secondary containment secondary containment barriers of the fuel capsule. (auth) (STAR)

2341 (ORNL-4470, pp 199-203) REACTOR EVALUATION. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

Continued assistance to the AEC by developing computer codes for the analysis of the economics involved in fuel cycle and codes for the analysis of fuel element performance is reported. A fuel performance model and computer code for pin-type fuel elements are being developed to more effectively coordinate present performance evaluations with radiation experiments being conducted at ORNL and elsewhere. The computer code development for economics analyses is being done to incorporate more detailed analysis of individual steps involved in fuel element fabrication and to model the management decisions required in a growing nuclear economy. In addition to these efforts, assistance in the evaluation of several reactor concepts during the year is reported. (auth)

2342 (UCRL-71611) LOW-SPEED DIAMOND SAW. Albrecht, E. D.; Stearns, E. H.; Wittmayer, F. J. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 29, 1969. 24p. (CONF-690920-4). Dep. CFSTI.

From 2nd Annual Technical Meeting of International Metallographic Society, San Francisco, Calif.

A low-speed diamond saw was developed for use in cutting experimental and metallographic specimens. A 3-in. diameter diamond edge blade having a total thickness of 0.006 in. was used. The blade revolved at approximately 200 rpm is opposed to the 2000 ± rpm generally used in diamond sawing. Various materials including ceramics as well as soft and hard metals were cut. X-ray diffraction patterns revealed less surface disturbance on low-speed diamond sawed surfaces than on those produced by spark-cutting or high-speed diamond sawing. (auth)

2343 SOLENOID MAGNET DESIGN. THE MAGNETIC AND MECHANICAL ASPECTS OF RESISTIVE AND SUPERCONDUCTING SYSTEMS. Montgomery, D. Bruce. New York, John Wiley and Sons, Inc., 1969. 323p. $13.95.

The design of magnets involving currents only is covered and not magnets involving iron circuits. The coils are divided into three categories: steady-state dissipative coils, steady-state nondissipative (superconducting) coils, and transient pulse field coils. The relations between current and central field for coils of various shapes and typical distributions of current are developed. The relations between current and other basic design parameters such as power, energy, coil volume, magnetic stresses, cooling requirements, and current density are developed as well. Finally, the relations between the central field and fields at all other points are treated from the standpoints of analysis and synthesis. Most of the formulas are presented that would be needed by a designer in the majority of commonly encountered air-core magnet designs. In addition to the formulas and design charts, the methods of attack and a discussion of the relative importance of the design variables are presented through formulation, graphs, and examples. (M.H.R.)

2344 DESIGN OF A DOUBLE WALL HEAT EXCHANGER FOR HAZARDOUS SERVICE. Shapiro, Theodore (Oak Ridge Gaseous Diffusion Plant, Tenn.). Chem. Eng. Progr., 65: Symp. Ser. No. 92, 64-9(1969).

From 10th National Heat Transfer Conference, Philadelphia, Pa. See CONF-680832.

In the course of design work done on the pilot plant for the fluidized bed volatility process, the need for complete isolation of the process stream and heat exchange media was indicated. To remove the heat of compression from the high speed compressor developed for the process, a heat exchanger of unusual design was fabricated and tested. The test demonstrated the feasibility of using an annular space with short high efficiency fins as a buffer zone between the potentially hazardous fluids. Heat transfer coefficients obtained by calculation are compared with tests of a prototype, and a mathematical model is presented for determining the resistance of the air gap in the annular space. (auth)

2345 GLASS MANIFOLD VACUUM SYSTEM FOR CONTROLLING ATMOSPHERE AND WATER CONTENT OF SEEDS FOR IRRADIATION EXPERIMENTS. Conger, B. V.; Konzak, C. F.; Harle, J. R. (Washington State Univ., Pullman). Radiat. Bot., 9: 425-7(Oct. 1969).

It is known that atmosphere, and particularly oxygen, is a major modifying factor of radiation damage in dry biological systems, such as resting seeds; seed water content is also such a factor and is intimately related to the oxygen factor. Therefore, it is of great importance that these two factors be strictly controlled during irradiation and post-irradiation treatment of seeds. It was found that the best control can be achieved by irradiating the seeds in vacuo, and for this purpose the described glass manifold system was constructed. (UK)

2346 IMPROVEMENTS RELATING TO HOISTS FOR CONTROL RODS OF NUCLEAR REACTORS. Dean, John Raymond; Morgan, Alun Charles Lester (to A. Reyrolle and Co. Ltd.). British Patent 1,165,137. Sept. 24, 1969. Filed July 21, 1967.

The object of the system described is to provide an emergency shutdown control rod hoist having fail-safe characteristics. A driving motor is coupled to the hoist through an electromagnetic clutch. Details are given of various alternative designs of clutch. A winding drum is coupled to the driving motor through the clutch, and a permanent magnet eddy current brake is arranged to act on the drive transmission between the clutch and the winding drum. (UK)

2347 INERTIA EFFECTS IN MHD HYDROSTATIC THRUST BEARING. Kamiyama, S. (Tohoku Univ., Sendai). J. Lubric. Technol., 91: 589-96(Oct. 1969).

An approximate analytical study is made of inertia effects in magnetohydrodynamic lubrication flow between two parallel disks, one of which rotates at a constant angular velocity in an axial magnetic field. Fairly good accuracy of the approximate solution is confirmed in the special limiting case of zero rotating speed. By the numerical examples, the inertia effects on pressure distribution, load capacity, and frictional torque of the bearing are clearly shown. (auth)

2348 ROTARY ELECTRICAL AC GENERATORS UTILIZING THE MAGNETIC SHIELDING AND TRAPPING BY SUPERCONDUCTING PLATES. Kawabe, Ushio; Kudo, Mitsuhiro; Hara, Nobuhiro; Doi, Toshio (Hitachi Ltd., Tokyo). J. Appl. Phys., 40: 4454-7(Oct. 1969).

Superconducting rotary ac generators were developed utilizing magnetic shielding and trapping between many pairs of hard superconducting plates. To show the possibilities of the proposed generators, models I and II were constructed and tested in liquid helium at 4.2°K. Two heat-treated Nb–40Zr–10Ti plates (40-mm diam and 8-mm thick) with three keyhole-shaped slots were used for the rotor of the model I, and sintered Nb_3Sn discs (17.5-mm diam and 8.0-mm thick) embedded three by three in three 40-mm-diam bakelite plates were used for model II. When model II was operated at 1000 rpm with a resistance load in a state in which a field of 1.4 kG was trapped between disks, a maximum output power of 5.72 W was obtained with 6.5 A (rms) and 0.88 V (rms). The electrical efficiency was 89%. The total power loss was 0.72 W, 58% of which was mechanical bearing loss. (auth)

2349 IMPROVEMENTS IN OR RELATING TO VAPOR GENERATORS. (to Gulf General Atomic Inc.). British Patent 1,166,305. Oct. 8, 1969. Priority date Sept. 22, 1966, United States.

A nuclear power reactor system is described which includes a reactive core, a fluid circulating system, and vapor generators enclosed within the reactor vessel. An improved design of a vapor generator is given for a nuclear reactor having a flowing coolant. Many fluid conducting heat exchanger tubes are positioned in the coolant flow and designed with a different material at each end, the materials having different thermal coefficients of expansion. The tubes are welded at the midpoint. The tubes are positioned behind baffles at the weld point to deflect the coolant flow from the welded sections. Reheaters are positioned adjacent to the exchanger tubes such that the coolant passes over the reheater before passing over the heat exchanger tubes. (J.C.W.)

2350 IMPROVEMENTS IN OR RELATING TO VAPOR GENERATORS. (to Gulf General Atomic Inc.). British Patent 1,166,304. Oct. 8, 1969. Priority date Sept. 22, 1966.

A nuclear power reactor system is described which includes a reactive core, a fluid circulating system, and vapor generators enclosed in the reactor vessel. An improved design of a vapor generator is given for a reactor having a flowing coolant. Many fluid conducting heat exchanger tubes are positioned in the coolant flow, with some tubes comprising a reheater disposed toward the direction from which the coolant flow is directed so that the coolant will pass over the reheater before passing over the remainder of

the heat exchanger tubes. The reheater has a device for connection to a source of auxiliary coolant for providing a flow through the reheater for removing heat from the flowing coolant in the event of vapor–liquid system failure. (J.C.W.)

2351 APPARATUS FOR CHECKING DISTORTION OF A REACTOR FUEL ELEMENT. Creek, Kenneth O. (to U. S. Atomic Energy Commission). U. S. Patent 3,476,825. Nov. 4, 1969.

A device for checking distortion of a reactor fuel element is described. The fuel element is placed in a semicylindrical shell which simulates the reactor tube in which the fuel element normally operates. A probe is moved along the fuel element to measure the spacing between the sections of the fuel element and the spacing between the fuel element and the semicylindrical shell. The fuel element is translated and rotated to various positions during the course of the probing. (AEC)

2352 FUEL SEGREGATION LOADING ARRANGEMENT IN–NUCLEAR FUEL ELEMENTS. Turner, Richard F. (to U. S. Atomic Energy Commission). U. S. Patent 3,476,645. Nov. 4, 1969.

An improved design of a nuclear breeder reactor fuel element comprising closely disposed masses of fissile fuel and fertile material in a graphite matrix is described. Respective half-round rods, one of fertile and one of fissile material, are paired and disposed in ranks of parallel, coplanar bores in the graphite matrix, with the interfaces between the paired half-round rods defining a common plane, with the fissile masses being uniformly upon one side of the plane and the fertile masses upon the other. Although in service the rods and matrix may become bonded into a monolith, the array affords ready separation of the spent fuel element into fissile and fertile portions by sawing along said common plane. (AEC)

2353 IRRADIATION DEVICE WITH RADIATION-SOURCE RODS. Tsuzuki, Tadaiti (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-11914. May 17, 1969. Filed July 31, 1965.

When irradiating samples with radiation-source rods, the rods are assembled in the form of a cage, with samples placed appropriately close to the rods. The cage is supported on the base, which is fixed in the irradiation cell. By the method proposed, the replacement of one cage with another to change the conditions of irradiation, can be done in a safe manner; the operation is both easy and positive. The irradiation device with the replacement mechanism, consists of the following: the cylindrical base with a collar in the middle; a rod inserted into the bottom end of the base; a cylinder with the top circular-table which is placed around the top of the cylindrical base; the cage of radiation-source rods assembled onto the circular table; horizontal holes cut through the walls of both the cylindrical base and the circular-table cylinder into which thick pins are inserted by way of springs; and a mechanism installed in the middle of the circular table to lock and unlock the pins. (NSA of Japan)

2354 APPARATUS FOR THE PRODUCTION OF POLYMERS BY IRRADIATION. Gardner, John B.; Smith, Charles F.; Harper, Billy G. (to Dow Chemical Co.). U. S. Patent 3,472,752. Filed Nov. 13, 1967.

A reactor for simultaneous polymerization of a plurality of polymerizable monomeric streams is described. Structurally the reactor has a central tubular core containing a high energy radiation source. Such core is surrounded by a plurality of concentric tubular reactor shells disposed outwardly from the central core and which form a plurality of reaction annuli around the central core. The reactor also provided with means for introducing the polymerizable material into each of the reaction annuli and means for removing the polymerized product. (Offic. Gaz.)

2355 ATOMIC ENERGY COMMISSION HAS OUR MOST REMOTE WASTE TREATMENT SYSTEM. Water Sewage Works, 115: 308-9(July 1968).

The waste disposal system at the U. S. Atomic Energy Commission's underground nuclear test site on Amchitka Island is described. This island is at the far end of the crescent-shaped Aleutian chain, and rises out of the Bering Sea. Its location affords an ideal site for the largest underground nuclear explosions that have been conducted. Although only a skeleton work crew of 400 was required to drill the test hole through Amchitka's flint-like rock, the federal government was sufficiently concerned with waste treatment and its effect on wildlife that an Interior Department representative was detailed to watch over the operation. Plans and specifications were drawn by the U. S. Army Corps of Engineers and executed by a private contractor to take full account of the wildlife problem. In selecting a waste treatment system, the guidelines set forth by the U.S. Public Health Service were followed. Because of the temperature range, the fog-bound environment and the high degree of treatment required, the U.S. Army Corps of Engineers selected an AIR-AQUA aerated lagoon system. Two lagoons were planned, separated by a watertight baffle. Each lagoon was 10 ft deep, the largest measuring 0.57 acres, and the smaller only 0.25 acres. Present flow is 35,000 gpd with an expected future flow of 100,000. Loadings (5-day BOD) were 60 lb BOD/day with a future loading of 170 lb BOD/day. The large lagoon has a detention time of 23.7 days, and a volume of 2,337,740 gal. The small lagoon has a detention time of 11.2 days, and a volume of 1,126,140 gal. Specifications, which called for primary settling, biological oxidations, final settling, sludge disposal, odor control, and effluent polishing, are described. (BBB)

2356 PRESENT STATE OF THE SEAWATER INTAKE AND RELEASE FACILITIES FOR THE JAPC TOKAI POWER STATION. Tsujimoto, Susumu; Onishi, Sotoaki (Japan Atomic Power Co., Tokyo). Karyoku Hatsuden, 20: 285-97(Mar. 1969). (In Japanese).

The Tokai power station employs a Calder Hall-type reactor; the steam from turbogenerators is condensed by cooling with seawater. The seawater is taken from a point about 500 m from the beach in the Pacific Ocean. Two steel conduit pipes are used that run from the intake point through sand settlers and pumps to the steam condenser; the seawater from the condenser is returned to the sea through other channels. Construction of the facilities were made more difficult because of the rough waves of the Pacific, and subsequent maintenance and repair for the past two years also involved many problems. A discussion is given on the inflow of earth and sand into the conduit pipes and seawater intake openings, attachment of sea life onto the inner surface of the steel conduit pipes, corrosion of the steel conduit pipes, digging of seabed by the released seawater, and increase of seawater temperature due to the released seawater. (NSA of Japan)

2357 HIGH PRESSURE METHODS IN SOLID STATE RESEARCH. Bradley, C. C. New York, Plenum Press, 1969. 180p. $12.00.

Apparatus for generating and measuring static pressures up to 500 kbars is described. Hydrostatic, opposed-anvil, multi-anvil, and piston-cylinder apparatus are considered. Specifications are listed for materials used in the apparatus. (D.L.C.)

2358 STUDIES OF EXPANSION JOINT BELLOWS. Koatsuryoku, 7: 1518-25(Jan. 1969). (In Japanese).

In the piping of the primary cooling system for the Calder Hall-type improved power reactor of the Japan Atomic Power Co., many large expansion joints of about 1.5 m diameter are used for the design conditions of 400°C and 16 kg/cm^2 pressure. Stress analyses were conducted for these expansion joints. The welding method and structural design for the expansion joints in the reactor plant were also studied. It was found that a two layers bellows has twice as much stiffness as a single layer bellows. The local plastic deformation occurs at the valley and peak parts of the expansion joint in the practical displacement range. The strain condition in case of simultaneous action of the axial load and the internal pressure was determined. (NSA of Japan)

2359 DESIGN AND APPLICATIONS OF METERING PUMPS IN NUCLEAR ENGINEERING. Vetter, G.; Hessenberger, R.; Holzaepfel, E. (LEWA Herbert Ott, Leonberg, Ger.). Kerntechnik, 11: 577-89(Sept.-Oct. 1969). (In German and English).

The design of a metering pump for use in the nuclear industry is given. Gears, drives, servo-motors, membranes, and hydraulic fluids and their differentiation from conventional components are discussed. Installation considerations of a metering pump apply to pressure conditions to which the pump will be subjected. Special requirements include leak-tightness, cleanliness, reliability, and resistance to irradiation and corrosion. (J.C.W.)

2360 RADIOACTIVE-SOURCE ENCLOSURE. Goodman, Ronald H.; Bettens, Arsene H.; Josling, Clifford A. (to Canadian Patents and Development Ltd.). U. S. Patent 3,476,939. Priority date Feb. 11, 1965, Canada.

The design is given of a radioactive-source enclosure having movable shielding gates which, when free to move under their own weight, assume a position sealing off the radioactive source preventing any escape of radiation from the enclosure. In normal operation these gates are held open by a locking mechanism which, on failure of the power supply to the sorting apparatus, allows the gates to close and locks them shut in the closed position. (Offic. Gaz.)

2361 TESTING NUCLEAR FUEL IN MULTIPLES. Power, 113: 123(Nov. 1969).

A reactor component test facility is described. The test loop associated with the facility is constructed of 16-in. schedule 140 stainless steel pipe and has two test stations designed for 2500 psig and 650°F service. Maximum loop flow is 15,000 gpm at 275 ft of developed head. Operation and uses of the loop are discussed. (J.R.D.)

2362 PLUG ASSEMBLY WITH A FUSIBLE SEAL. Cayol, Andre (to Commissariat a l'Energie Atomique). British Patent 1,170,197. 12 Nov 1969. Priority date 29 Sep 1967, France.

A plug assembly for fuel pins is described. A housing is secured to the cladding of the pin incorporating a passage to the inside of the cladding and to an opening at the outside. A valve member is soldered to the wall of the outlet. A spring is compressed between the housing and the valve that is designed to lift the valve clear of the outlet when the solder is melted. The solder melts at reactor temperature. In this way the pin is sealed at room temperature but open to allow gaseous fission product escape at reactor temperatures. (J.R.D.)

2363 DISTILLATION AND POWER GENERATING METHOD AND APPARATUS. (to American Machine and Foundry Co.). British Patent 1,169,263. 5 Nov 1969. Priority date 18 Apr 1966, United States.

The apparatus comprises a flash evaporator incorporating several stages operable at successively lower pressures to establish a high pressure stage at one end and a low pressure stage at the other. The heated feed solution introduced in the high pressure stage passes serially through the stages to the low pressure end and a portion of the feed flashes into vapor at each stage and is condensed as distillate. The apparatus may be used with a reaction for desalination. (J.R.D.)

2364 IMPROVEMENTS IN ONCE-THROUGH VAPOUR GENERATORS. (to Babcock and Wilcox Co.). British Patent 1,171,492. 19 Nov 1969. Priority date 21 Jan 1966, United States.

The generator contains a bank of U-shaped tubes each incorporating an inlet limb and an outlet limb connected by a U-bend. The inlet limbs are connected to a common inlet and the outlet limbs are connected to a common outlet. A baffle in the shell divides the interior of the shell into a space that contains the outlet limbs and a space for the inlet limb ends. These spaces are connected to the flow path so that fluid admitted to the shell flows first through the space containing the outlet limbs then through space for the inlet limb ends. (J.R.D.)

Heat Transfer and Fluid Flow

Refer also to abstracts 2344, 2412, 4049, 4150, and 4169.

2365 (AD-690894) A POINT EXPLOSION IN A COLD EXPONENTIAL ATMOSPHERE. PART 2. RADIATING FLOW. Laumbach, Dallas D.; Probstein, Ronald F. (Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.). Apr. 1969. Contract Nonr-1841(93). 55p. (Pub-69-3). CFSTI.

The problem considered is that of a strong shock propagating from a point energy source into a cold exponential atmosphere with radiative heat transfer in the flow behind the shock. The radiation mean free path is taken to be small compared with the shock radius so that the shock may be treated as discontinuous and the radiative heat flux represented by the Rosseland diffusion approximation. The solution obtained is an approximate one based upon the local radiality assumption and integral method previously utilized for the case of adiabatic flow. A radiation parameter is developed which provides an index as to when the effects of radiation may be neglected and the flow taken to be adiabatic. The physical interpretation of this parameter is that of the ratio of a characteristic radiation energy flux to a characteristic kinetic energy flux. It is shown that when the radiation mean free path varies as a power of the temperature (T to the nth power), where $n = -17/6$, the infinity of solutions for various polar angles can be transformed into two distinct solutions thereby essentially eliminating the parametric dependence on the polar angle and the atmospheric scale height. (auth) (USGRDR)

2366 (AERE-R-6117) THE INFLUENCE OF HEAT FLUX, SUBCOOLING, WALL THICKNESS AND TYPE OF HEATING ON FILM FLOW IN THE EVAPORATION OF WATER IN A VERTICAL TUBE. Hewitt, G. F.; Pulling, D. J. (Atomic Energy Research Establishment, Harwell (England)). June 1969. 20p. Dep. CFSTI (U. S. Sales Only). UK 3s. 0d.

Liquid film flow measurements in evaporating vertical flow are described and discussed. The effect of subcooling the inlet water feed and the effects of reduction of wall thickness by grinding were investigated using a tube of 0.366 in. diameter and fixed total mass velocity of 2.19×10^6 lb/hft^2. Tests were also carried out under similar conditions with ac and dc heating. With the thinnest wall small differences with the two types of heating were observed, but ac effects could not be invoked in complete explanation of the small but significant effect of wall thickness on film flowrate. Tests are also reported in which the influence of heat flux on the rate of change of liquid entrainment flow with length was investigated in various regions. Under the conditions applying, heat flux appeared to have a negligible effect on net rate of entrainment or deposition. (UK)

2367 (AI-AEC-12767) STUDIES OF BOILING INITIATION FOR SODIUM FLOWING IN A HEATED CHANNEL. Logan, D.; Baroczy, C. J.; Landoni, J. A.; Morewitz, H. A. (Atomics International, Canoga Park, Calif.). Sept. 30, 1969. Contract AT(04-3)-701. 133p. Dep. CFSTI.

Data are presented for incipient boiling superheat for sodium flowing upward in a vertical annulus formed by a heated stainless steel tube of ¼-in. diameter located inside a tube of ½-in. diameter. The data cover the following ranges: heat flux, 0.09×10^6 to 0.825×10^6 Btu/hr-ft^2; pressure, 2 to 15 psia; inlet subcooling, 20 to 300°F; sodium velocity, 2 to 6 ft/sec; and wall superheat, 0 to 241°F. All-liquid heat transfer relationships permit clear identification of the major trends due to heat flux, velocity, and inlet subcooling and thereby allow improved interpretation of the incipient boiling data. The application of various boiling inception theories to forced convection, liquid metal systems is examined and evaluated. For the maximum observed superheats, consideration of the dominant physical forces results in a dimensionless plot of wall superheat vs Reynolds number and shows the trends to be expected for forced convection laminar and turbulent flow in LMFBR systems. (auth)

2368 (CEA-R-3560) THERMAL AND HYDRODYNAMIC STUDY OF A WHIRLING LIQUID HYDROGEN LAYER UNDER HIGH HEAT FLUX. Ewald, Rolf (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug. 1969. 96p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Grenoble Univ., France.

In order to achieve a cold neutron source ($\lambda \geq 4$ Å) in a high flux reactor ($\approx 10^{15}$ neutrons/cm^2/sec), a whirling liquid hydrogen layer (145 mm OD, effective thickness 15 mm, and height about 180 mm) was formed, out-of-pile, in a cylindrical transparent glass vessel. The whirling motion was obtained by tangential injection of the liquid, near the wall. Thermal and hydrodynamic conditions of formation and laws of similarity of such a layer were studied. The characteristics of this whirling flow were observed as a function of mass flow rate (5 to 27 g/sec; 4.3 to 23 l/mm), and of spillway width (18 and 25 mm). Six different nozzles were used: 1.0; 1.5; 1.9; 2.25; 2.65 and 3.0 mm ID. The total heat influx was found between 8.6 and 10.4 kW. The heat flux density was about 9.4 W/cm^2 and the mean layer density around 80 per cent of that of the liquid hydrogen at 20.4°K. High speed movies were used to analyze the boiling regime. (auth)

2369 (CEA-R-3699) POSSIBILITY OF GAS FLOW MEASUREMENTS USING IONIZATION PRODUCED BY RADIOACTIVE SOURCES. PERFORMANCE OBTAINED USING CONTINUOUS AND PULSED IONIZATION. Toudoire, Bruno (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 165p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay, France.

Two methods for measuring gas flow were studied, based on the ionization of the fluid by a radioactive source. In the first, called the continuous method, use is made of the relationship between the flow and the ionic density at a point situated downstream from the ionizing source. In the second method, called "pulsed," the time for a burst of ions to pass between two points in the circuit is measured. An attempt has been made to predict and to justify theoretically the experimental results, and to determine to what extent these methods can provide absolute measurements or measurements requiring a calibration using known gas flows. These methods are characterized by the absence of moving parts or of parts under reduced pressure and can yield results with an accuracy of between a few per cent to a few tenths of a per cent. The information, provided in either analog or digital form, can be adapted for use in servo-mechanisms or automatic systems. Two applications of an industrial type are described; they concern gas-flow measurements in a railway braking circuit, and in tubes of 20 and 30 cm diameter. (auth)

2370 (CISE-R-104) ANALYSIS OF THE DYNAMIC PERFORMANCE OF A DILATOMETER TECHNIQUE FOR THE MEASUREMENT OF TOTAL STEAM VOLUME IN A HEATED CHANNEL.

Topical Report No. 6. van Erp, J. B. (Centro Informazioni Studi Esperienze, Milan (Italy)). Feb 1964. 40p. Dep. CFSTI (U. S. Sales Only).

A dilatometer technique was used for measuring total steam volume in a heated channel under steady-state conditions. The dilatometer employed consists either of a burette (directly readable) or a bellows-system, the latter giving an electrical output by means of a strain gage bridge. An analysis is given of the performance of the dilatometer technique under dynamic conditions. It was necessary to introduce certain approximations. It was found that the technique introduces, under certain conditions, disturbances into the system to be measured; methods are indicated to minimize these disturbances. (auth)

2371 (CISE-R-121) DYNAMIC SIMULATION OF STEAM DRUM, STEAM PIPES FROM DRUM TO TURBINE AND STEAM TURBINE. Topical Report No. 14. Muscettola, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). July 1964. Contract 005-63-7-NTRI. 52p. Dep. CFSTI (U. S. Sales Only).

Dynamic models have been derived for a steam drum, steam pipes from the drum to the turbine, and a saturated steam throttle governing controlled turbine. (auth)

2372 (CISE-R-132) DENSITY DYNAMICS ACCORDING TO THE HOMOGENEOUS FLOW MODEL FOR A VAPORIZING TWO-PHASE MIXTURE IN A HEATED CHANNEL. Topical Report No. 16. Possa, G. (Centro Informazioni Studi Esperienze, Milan (Italy)). Sept. 1964. 33p. Dep. CFSTI (U. S. Sales Only).

The transient behavior of the density of a vaporizing coolant in a heated channel was determined using a model in which equal linear velocities were assumed for the gaseous and liquid phase in the bulk boiling region. The procedure outlined allows the determination of density transients in the nonlinear and the linear range, in which limits for a set of transfer functions were derived. (auth)

2373 (CISE-R-134) MEASUREMENTS ON THE DYNAMICS OF SINGLE-COMPONENT TWO-PHASE FLOW IN A HEATED CHANNEL. Topical Report No. 17. Era, A.; Fantone, G.; Possa, G.; van Erp, J. B. (Centro Informazioni Studi Esperienze, Milan (Italy)). June 1965. 65p. Dep. CFSTI (U. S. Sales Only).

Experimental data are presented regarding the dynamics of a water/steam mixture, employed as a coolant in a heated channel. A dilatation technique is used in closed-loop operating for total steam volume measurement. The measurements were carried out in the low pressure range (9 kg/cm^2) and for a tubular test element geometry. Presented are transfer functions and describing functions in the frequency range of 0.02 to 2 cps, with test-element power and inlet enthalpy as independent variables, and total steam volume and system pressure as dependent variables. A considerable part of the data covers the region of high outlet qualities. (auth)

2374 (CISE-R-142) ANALYSIS OF EXPERIMENTAL DATA REGARDING TWO-PHASE FLOW DYNAMICS. Topical Report No. 19. Fantone, G.; Possa, G.; van Erp, J. B. (Centro Informazioni Studi Esperienze, Milan (Italy)). Jan. 1966. Contract 005-63-7-NTRI. 50p. Dep. CFSTI (U. S. Sales Only).

An analytical method is presented which permits processing of experimental data on two-phase flow dynamics (acquired by means of the dilation technique) into a form which is less dependent on loop geometry. The derivation of the pressure-to-coolant density transfer function from the power-to-coolant density transfer function (at constant pressure) and the power-to-pressure transfer function (at constant volume) is shown. Transfer functions in the frequency range of 0.2 to 2 cps are presented in graphs with power, inlet enthalpy, and pressure as independent variables, and average coolant density as dependent variable. (auth)

2375 (CISE-R-161) ONESTO: A DIGITAL CODE TO CALCULATE STEADY STATE HYDRODYNAMIC PARAMETERS IN A BOILING CHANNEL. A Revised and Enlarged Edition. Topical Report No. 9. Brusa, L.; Ghirardi, A.; Muscettola, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). July 1965. Contract 006.64.4-NTRI. 76p. Dep. CFSTI (U. S. Sales Only).

ONESTO, a code for the Olivetti ELEA 6001 digital computer, is described which evaluates the steady-state critical power ratio and hydrodynamic conditions for the flow of a steam-water mixture in a channel, when inlet conditions are given. The code calculates pressure drop, steam quality, steam volume fraction, and mixture density along the channel, both for adiabatic flow and with power addition. When the inlet enthalpy is below the water saturation enthalpy, the code determines the position in the channel at which the subcooled water reaches saturation. Since channels, in which the initial part has a reduced flow area due to the introduction of a rodlet are of interest, the code can deal with channels having discontinuously increasing flow areas. Concentrated pressure gains at discontinuities are introduced in an approximate form. In the given formulation two sub-routines are included for axial power distribution constant and sinusoidal. The basic equations used to characterize the hydrodynamic conditions of the mixture are derived from the laws of conservation of mass, momentum and energy. Experimental correlations for two-phase flow pressure drops and steam volume fraction have also been used. The actual mean density and two squared flux weighted mean densities are computed by the code. (auth)

2376 (CISE-R-169) HEAT TRANSFER CRISIS WITH STEAM-WATER MIXTURES: AN EXPERIMENTAL STUDY ON THE INCREASE OF CRITICAL POWER WITH LOCAL SWIRL PROMOTERS IN ROUND TUBES. Topical Report No. 5. Hassid, A.; Manzoni, G. C.; Ravetta, R.; Rubiera, L. (Centro Informazioni Studi Esperienze, Milan (Italy)). May 1966. Contract 008.65.1-NTRI. 109p. Dep. CFSTI (U. S. Sales Only).

Experimental data are presented and analyzed on possible means of increasing critical power with vertical upward flow of steam-water mixtures in round conduits, and of reducing the H_2O content in such power channels by introducing filling unheated rods. The experiments were carried out under the following conditions: geometry: heated round tube 1.5 cm diameter without or with a partially or completely filling rod (0.6 cm to 1.0 cm OD); heated length: 30 to 400 cm; specific mass flow rate: 110 to 380 g/cm^2 sec; inlet steam quality (by weight): −0.20 to 0.60 (subcooling from 70 + 80°C); and pressure: 51 and 71 kg/cm^2 abs. The most investigated means for increasing critical power was to induce swirl flow by small promoters (~5 cm length) suitably located along the channel. These promoters have noticeable advantages with respect to the full length twisted tapes already suggested and investigated in other laboratories. About 800 experimental points of heat transfer crisis are presented and discussed. The main conclusion is that substantial critical power increases could be obtained for elements in conditions quite close to those foreseen for reactor cooling. (auth)

2377 (CISE-R-176) ANALYTICAL CONSIDERATIONS OF TEMPERATURE OSCILLATIONS OF A WALL COOLED BY A TWO-PHASE MIXTURE IN SUPERCRITICAL CONDITIONS. Topical Report No. 13. Mazzotti, G.; Lombardi, C. (Centro Informazioni Studi Esperienze, Milan (Italy)). Nov 1966. 68p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The heat transfer crisis of a heated surface cooled by two-phase mixture was determined by the onset of wall temperature fluctuations, which increase markedly with power input; simultaneously the difference between wall and bulk temperatures (time averaged) begins to increase much more rapidly with power input. The mechanism which is considered to be responsible for these oscillations is the wetting-unwetting of the wall by the liquid film which starts disrupting at the critical power. Continuous operation of fuel elements beyond crisis is not expected in steady state conditions; this might occur only for short transients. Since however, the material is submitted to heavy thermal cycling, an analytical study of the phenomenon was undertaken. Usually the experimental conditions refer to an electrically heated wall whose thermal capacity is low. It was studied whether this parameter, generally higher in a fuel element, might damp these temperature oscillations on the layer in contact with the cooling medium. This phenomenon was investigated in the case of a heat resistance (R) varying with time (t) and space (z) as: $R(z,t) = R + r \operatorname{sen} \lambda(z + vt)$. It resulted that the damping effect due to heat transfer capacity of the overall heated wall on the oscillation amplitude of the layer in contact with the mixture, rapidly reaches saturation, i.e., for a given material there is a value of the wall thickness beyond which the reduction in these temperature oscillations is no longer appreciably affected. This is understandable from a physical standpoint because in the farthest layers the temperature waves arrive more and more attenuated so that their inertial contribution to the layer in contact with the coolant becomes more and more unimportant. It is interesting to note that for different materials as Zircaloy, stainless steel, uranium metal an uranium oxide the "saturation" thickness does not vary appreciably: for instance with the following numerical values: R = 1.1°C/W/cm^2; r = 0.9°C/W/cm^2; T = ls(= 2π/λv); v = 0.5 cm/sec; it is in the range of 0.60 to 0.75 mm. If these values were in the right range, major differences should not be expected between experimental behaviour and that obtained in a reactor channel. The study also resulted in identification of four dimensionless parameters which may completely describe the dynamic behaviour of the wall. The heavy drawback of this procedure is due to the uncertainty of the numerical values to be assigned to the parameters involved in the phenomenon. It seems however that the attenuation of the temperature oscillations on the external layer due to the wall thermal inertia is of the order of 0.5. Moreover, to this effect has to be added the attenuation inside the wall, which may be of the same order of magnitude for

wall thickness of 1 mm. Finally it was found that the decoupling effect due to thermal resistance between fuel and cladding is almost negligible in many practical cases. (auth)

2378 (EURFNR-695) TEMPERATURE DISTRIBUTION AND THERMAL STABILITY IN ASYMMETRICAL TRIANGULAR ROD-CLUSTERS. Fischer, M.; Shimamune, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Apr. 1969. 51p. (KFK-724; EUR-4178). Dep. CFSTI (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

A theoretical analysis is presented of fluid flow and heat transfer for axial turbulent flow in asymmetrical triangular rod-clusters caused by thermal bowing or fabrication inaccuracies. The method is applicable to calculate distribution of local shearing stress, coolant velocity, coolant temperature and local surface temperature. It can be used to predict the stability of bowed fuel rods and to decide the proper spacing of the supports. Numerical results are obtained for steam cooled fuels by eddy diffusivity and arc depth of bowing as parameters. Theoretical considerations are also applicable to sodium coolant. (auth)

2379 (ORO-3326-1) BUBBLE INITIATION IN SUPERSATURATED SOLUTIONS. Final Report. Himmelblau, D. M. (Texas Univ., Austin. Dept. of Chemical Engineering). Apr. 8, 1969. Contract AT(40-1)-3326. 78p. Dep. CFSTI.

The effects of radioactive particles, surface characteristics, and the radius of curvature of the nucleating particles on bubble nucleation were studied in supersaturated solutions of CO_2 and water. To study the effects of radioactive particles on bubble nucleation, various energies of radioactive particles were passed through supersaturated solutions to determine if they caused any difference in the previously observed bubble nucleation process. Surface characteristic effects were studied by observing differences in the amount of supersaturation necessary to cause bubble nucleation on particles of the same size but different surfaces. Particles compared were polystyrene beads with bacterial spores and polystyrene beads with glass beads. The effects of the radius of curvature were studied by observing differences in the amount of supersaturation necessary to cause bubble initiation on identical spherical particles of different sizes. It was found that radioactive decay products with energies up to 5.3 MeV have no effect on bubble nucleation in clean supersaturated solutions, the surface characteristics of nucleating surfaces play an important role in bubble nucleation, and the radius of curvature of the nucleating particles is an important factor in the nucleating properties of the surface when the radius of the particle becomes less than 150 microns. (J.C.W.)

2380 FORCED CONVECTION BOILING FROM A CYLINDER NORMAL TO THE FLOW. McKee, Hugh R.; Bell, Kenneth J. (Oklahoma State Univ., Stillwater). Chem. Eng. Progr., 65: Symp. Ser. No. 92, 222-30(1969).

From 10th National Heat Transfer Conference, Philadelphia, Pa. See CONF-680832.

Boiling heat transfer from electrically heated cylinders was studied both in a pool and with forced flow normal to the cylinder axis. The cylinders were 0.25 to 0.71 in. O.D. and were mounted in a 3 in. square cross-section channel for the forced flow studies. The coolant was saturated water at atmospheric pressure in the pool and 3° to 14°F subcooled water at about 18 lb./sq. in. abs. and approach velocities of 3.42 and 5.44 ft./sec. in the forced convection studies. Local surface temperatures were determined at four peripheral positions on all but the smallest cylinder. Burnout heat fluxes for the 0.25-in. cylinder were 350,000 B.t.u./(hr.) (sq. ft.) for pool boiling, 673,000 B.t.u./(hr.) (sq. ft.) at 3.42 ft./sec., and 990,000 B.t.u./(hr.) (sq.ft.) at 5.44 ft./sec.; corresponding values for the 0.70-in. cylinder were 213,000, 312,000, and 287,000 B.t.u./(hr.) (sq. ft.). Peripheral temperature variation was generally small and appeared to be due more to local nucleation characteristics than to orientation to flow. Over the range of diameters and velocities tested, the burnout heat flux for forced convection decreased more rapidly with increasing diameter than indicated by previous studies on smaller diameter cylinders. (auth)

2381 NUCLEATE BOILING: A MAXIMUM HEAT FLUX CORRELATION FOR CORRESPONDING STATES LIQUIDS. Cobb, C. B.; Park, E. L. Jr. (Univ. of Missouri, Rolla). Chem. Eng. Progr., 65: Symp. Ser. No. 92, 188-93(1969).

From 10th National Heat Transfer Conference, Philadelphia, Pa. See CONF-680832.

A semitheoretical equation has been derived for correlating the maximum heat flux in the nucleate boiling of corresponding states liquids. Data, which include the boiling of liquid nitrogen, argon, oxygen, and methane on cylindrical and flat surfaces of gold, chrome, copper, iron, platinum, and teflon, have been correlated. For each boiling surface, a reference value was established which tended to normalize the data of various investigators and enabled a general correlation. Since only corresponding states liquids are considered, the correlating equation uses reduced temperature to correlate the data. Using the proposed correlation, one can predict high pressure maximum heat fluxes from low pressure data. (auth)

2382 EXPERIMENTAL BREEDER REACTOR NO. II. REACTOR HEAT TRANSFER: EXPERIENCE WITH AN OPERATING LIQUID METAL FAST BREEDER REACTOR. Cushman, R. A.; McGinnis, F. D. (Argonne National Lab., Idaho Falls, Idaho). Chem. Eng. Progr., 65: Symp. Ser. No. 92, 160-6(1969).

From 10th National Heat Transfer Conference, Philadelphia, Pa. See CONF-680832.

The calculational procedure for the temperature distribution within rod bundles of subassemblies of a fast irradiation test facility with a continually varying core is presented. The degree of agreement between calculated and measured temperatures is discussed. Temperature distributions within reflector and blanket subassemblies, together with a discussion of the large effect that radial heat transfer between reflector subassemblies has had on reactor operation, are presented. The problem of safety review of experimental irradiation subassemblies is discussed. (auth)

2383 LIQUID METAL BOILING IN RELATION TO LIQUID METAL FAST BREEDER REACTOR SAFETY DESIGN. Fauske, Hans K. (Argonne National Lab., Ill.). Chem. Eng. Progr., 65: Symp. Ser. No. 92, 138-49(1969).

From 10th National Heat Transfer Conference, Philadelphia, Pa. See CONF-680832.

Experimental and analytical studies pertaining to transient liquid metal boiling, including incipient liquid superheat, vapor growth, two-phase flow dynamics, vapor collapse, pressure pulse generation, and fuel-coolant interaction are reviewed. Their applicability to fast reactor safety design is discussed, and recommendations for future work are given. (auth)

2384 INITIATION OF POOL BOILING IN SODIUM. Holtz, R. E.; Singer, R. M. (Argonne National Lab., Ill.). Chem. Eng. Progr., 65: Symp. Ser. No. 92, 121-30(1969).

From 10th National Heat Transfer Conference, Philadelphia, Pa. See CONF-680832.

Experimental data obtained during the transient boiling of sodium in a highly polished (8 μin. average surface roughness) pool boiler are presented. The effects of system pressure, wall heat flux, and pressure-temperature history upon incipient boiling superheats are illustrated and compared with a previously published theoretical model. The effect of the pressure-temperature history is shown to be quite important, thus negating the value of much of the previously published incipient superheat data because the pressure-temperature histories are not available. In addition, the pressure transients caused by the vapor growth and collapse following the initial nucleation are presented and discussed. (auth)

2385 HEAT TRANSFER: PHILADELPHIA. Tenth National Heat Transfer Conference, Held in Philadelphia, August 11-14, 1968. Martini, W. R. (ed.). Chem. Eng. Progr., 65: Symp. Ser. No. 92, 1-263(1969). (CONF-680832).

Thirty-two papers on process heat transfer and heat transfer in fast reactors are presented. Separate abstracts were prepared for 6. Two appeared in NSA previously as 23: 15639 and 23: 15675. The remaining 22 were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 2344 and 2380-2384.

2386 HEAT TRANSFER. SECOND EDITION. Chapman, Alan J. New York, The Macmillan Company, 1967. 633p.

The importance of heat transfer; fundamental concepts and basic modes of heat transfer; fundamental laws of conduction, convection, and radiation; the general heat conduction equation; Newton's law of cooling; and the dimensions and units of conductance, conductivity, and diffusivity are discussed in general. Subjects included in the remaining chapters are material properties of importance in heat transfer; steady state heat conduction in one dimension; heat conduction in two or more independent variables; numericals and analog methods for heat conduction; fundamental principles of viscous fluid motion and boundary layer motion; application of boundary layer theory to problems of forced convection and an introduction to dimensional analysis; working formulas and dimensionless correlations for forced convection; heat transfer by free convection; heat transfer in condensing and boiling; heat transfer by radiation; heat transfer by combined conduction and convection; and cases of combined heat transfer including radiation. (J.C.W.)

2387 HEAT TRANSFER CRISIS IN HIGH PRESSURE WATER UNDER FORCED FLOW. PART II. HEAT TRANSFER IN THE REGION OF CRISIS. Herkenrath, H.; Moerk-Moerkenstein, P.

(EURATOM-CCR, Ispra, Italy). Atomkernenergie, 14: 403-7 (Nov.-Dec. 1969). (In German).

The conditions of the onset of a heat transfer crisis are discussed, and the trend of the heat transfer coefficient after the onset of the crisis, particularly in the section downstream the crisis, i.e., behind the minimum of the heat transfer caused by the crisis is described quantitatively. Diagrams describe the dependence of the heat transfer coefficient at the minimum (α_{min}) on the heat flux density, the pressure and the mass flow density. Further, a new correlation for the calculation of the heat transfer in the region of the crisis was developed. A comparison of some calculated values with own experimental results as well as those of other authors gave good agreement in the following parameter range: $170 < p < 215$ bar; $700 < q_m < 3500$ kg/m^{2}s; $30 < q_h < 180$ W/cm^2; and $5 < d_i < 20$ mm. The maximum deviation amounted to ±20%. (auth)

2388 MODERN DEVELOPMENTS IN GAS DYNAMICS. Loh, W. H. T. (ed.). New York, Plenum Press, 1969. 396p. $25.00.

Nine chapters on gas dynamics are included. A separate abstract was prepared for one. The other chapters contain information on the theory of the hydraulic analogy for steady and unsteady gas dynamics; combined heat and mass transfer processes; hypersonic viscous flows; hypersonic gas dynamics of slender bodies; hypersonic blunt-body gas dynamics; fundamentals of radiation gas dynamics; and some problems of radiative transfer. (M.H.R.)

For an abstract of the individual chapter see: 3229.

2389 NEW THERMODYNAMIC INTERPRETATION OF THE BOILING CRISIS. Basso, G. (Comitato Nazionale per la Energia Nucleare, Rome). Ing. Nucl., 10: No. 3, 7-27(May-June 1969).

Problems regarding thermal and/or hydraulic instabilities, arising under severe operating conditions in nuclear reactor cores which are cooled by non-saturated liquids, need to be extended to visco-elastic fluids to be correctly solved and interpreted on the basis of thermodynamic theory. The limiting conditions for stability in a diabatic flow are discussed and it is shown that burnout is associated with the onset and propagation of shock waves. In this context theoretical equations, which are in good agreement with predictions made when using empirical correlations, are derived for the critical heat flux. (auth)

2390 INTERACTION BETWEEN TEMPERATURES IN NONLINEAR HEAT TRANSFER PHENOMENA IN FUEL ELEMENTS. Furman, A. V.; Lyalikov, A. S.; Konovalova, L. S. Inzh.-Fiz. Zh., 17: 559-64(Sept. 1969). (In Russian).

The relationship between the temperatures of fuel element points is established under the conditions of non-linear heat transfer. It follows from the relationship that the temperatures for any point of the fuel element may be calculated if they are known at corresponding points of the surface. The relationship does not include either the values of thermal coefficients and heat transfer characteristics or energy sources. Experimental and numerical check of the relationship confirmed its sufficient accuracy. (auth)

Isotope Technology

Refer also to abstracts 2285, 2307, 2353, 2369, 2868, 2891, 2892, 2896, 2937, and 3052.

2391 (AERE-R-6138) HIGH INTENSITY ISOTOPE SEPARATOR ION SOURCE. Freeman, J. H. (Atomic Energy Research Establishment, Harwell (England)). July 1969. 15p. Dep. CFSTI (U. S. Sales Only). UK 3s. 6d.

The use of ion sources designed for isotope separators for studies of ion interaction and ion doping is discussed, and some modifications to the Harwell low voltage source to simplify assembly and improve performance are described. The source body is constructed mainly of Ta to reduce thermal mass and to minimize chemical reaction with corrosive vapors. The source is also fitted with an oven and a separate gas feed line. A sputtering probe for ionization of the Pt elements is provided, together with a vacuum loading assembly permitting the rapid introduction of solid samples during operation at high voltage. Water cooling at high voltage and ancillary arc-chamber heating are no longer required. The extracted ion beam can be precisely aligned by means of vacuum bellows and gimbals assembly on the external earth potential vacuum tank. (UK)

2392 (CEA-CONF-1303) MAKING A SOURCE OF IONS AT HIGH TEMPERATURE (2500 TO 3000°C) FOR THE ELECTROMAGNETIC SEPARATION OF ISOTOPES AT GRENOBLE. Bouriant, M.; Boge, M.; Dousson, S.; Griboval, P.; Bouchez, R. (Grenoble Univ. (France). Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). June 1969. 10p. (In French). (CONF-690625-2). Dep. CFSTI (U. S. Sales Only).

From International Conference on Ion Sources, Saclay, France.

The ion source described was originally designed for the production of ion beams with necessary qualities for obtaining very enriched isotopes. The source permits two principal versions: either a cathode with direct heating, or a cathode with indirect heating. The choice is made depending upon the value of the vapor pressure of the ionizing element. The performance of the source is discussed in particular as a function of temperature. The ion source was adapted for the separation of the ions of fission products. However, it cannot be used for radioisotopes with a half-life of less than 1 hr. (P.C.H.)

2393 (DP-1151) FORECASTING OF ^{252}Cf PRODUCTION VIA A SIMULATION MODEL. Knight, F. Delano; Christman, Ronald P.; Tharin, Catherine R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct. 1969. Contract AT(07-2)-1. 30p. Dep. CFSTI.

A computer program, CALICO, has been designed and written for the forecasting of ^{252}Cf production. This program provides estimates for ^{252}Cf and secondary products by simulating the interactions between a dual reactor system, a chemical separations plant, and a target fabrication facility. CALICO was written in FORTRAN IV for a 256 k IBM System/360-65 with a 2314 Direct Access Storage device. (auth)

2394 (JINR-P12-4590) PREPARATION OF CONCENTRATED CESIUM SOLUTIONS BY EXTRACTION AND PRECIPITATION CHROMATOGRAPHY METHOD. Maltseva, N. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A technique for the preparation of concentrated cesium solutions in small quantities with and without carriers from the nuclear reaction products is described. The possibility of applying this technique for preparation of cesium γ-sources of high specific activity is shown. (auth)

2395 (MLM-1698) SNAP-27 RADIOISOTOPIC HEAT SOURCE SUMMARY REPORT. Prosser, D. L. (Mound Lab., Miamisburg, Ohio). Nov. 11, 1969. Contract AT(33-1)-Gen-53. 8p. Dep. CFSTI.

Six SNAP-27 thermoelectric generators were fabricated to provide electrical power for the Apollo Lunar Surface Experiments Package (ALSEP), a series of five experiments to be performed on the lunar surface after the SNAP-27 is transported there by the Apollo 12. Each heat source is fueled with 3735 g of plutonium-238 dioxide microspheres which will produce 1480 thermal watts of power. The SNAP-27 heat source capsule was subjected to a comprehensive series of mechanical and environmental tests to ensure the integrity of the system prior to flight authorization. (auth)

2396 (ORNL-tr-1389) RADIOISOTOPE CONVERTER. Alleau, Thierry; Devin, Bernard; Vandevyver, Michel ([Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires]). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report CEA-R-2788. 15p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 39633. (L.C.L.)

2397 (ORNL-tr-1495) USE OF ACTINIDE ELEMENTS IN ISOTOPIC POWER GENERATORS. Berger, R. Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn.), from Bull. Inform. Sci. Tech. (Paris), No. 104, 23-34(May 1966). 18p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 31965.

2398 (ORNL-tr-2145) THE PREPARATION OF A ^{147}Pm-PHOSPHOR SOURCE. Wolf, P.; Rottmann, W. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Radiochim. Acta, 10: No. 3/4, 168-70(1968). 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 11724.

2399 (SC-RR-69-502) HELIUM: A COMPUTER PROGRAM TO CALCULATE THE HELIUM RELEASED IN FUEL CAPSULES CONTAINING ALPHA-EMITTING ISOTOPES. Northrup, C. J. M. Jr.; Milly, S. M. (Sandia Labs., Albuquerque, N. Mex.). Oct. 1969. 163p. Dep. CFSTI.

HELIUM is a computer program which calculates gas pressures

and quantities of helium in fuel capsules containing alpha-emitting isotopes. The program assumes that the transport mechanism for helium in the fuel particles may be described by classical diffusion. The volume of individual fuel particles must be small compared to the volume of the thermal nodes. Vacancy clusters, voids, and other materials defects are not treated explicitly and are accounted for only to the extent that they affect the diffusion coefficients. Both vented and unvented systems can be analyzed, with the computer output consisting of both printed listings and graphic plots. The program is written in Fortran IV for the CDC 6600 computer and utilizes the SCORS plotting routines to produce an output file for the S-C 4020 plotter. (auth)

2400 (UJV-2258-Ch) ON TERMS USED IN THE PRODUCTION OF RADIOISOTOPES BY CHARGED PARTICLE BOMBARDMENT. Svoboda, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Aug. 1969. 15p. (CONF-690924-1). Dep. CFSTI (U. S. Sales Only).

From International Conference on the Use of Cyclotrons in Chemistry, Metallurgy, and Biology, Oxford, England.

Definitions used in connection with the production of radioisotopes by charged particle bombardment are discussed. (L.C.L.)

2401 (WANL-3800-37) PHASE 1. Quarterly Progress Report, June 1, 1969-August 31, 1969. Wilgus, W. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Sept. 1969. Contract AT(30-1)-3800. 128p. (WANL-PR-SS-31). Dep. CFSTI.

Life testing of the Electrical Mockup System (EMS) continued during the report period. A performance data summary for this test program is included. Progress on design of the Fueled Prototype Mockup System (FPMS) is summarized. Performance data on the PMC series converters are also summarized. Design and development of SNAP-23A fuel capsule 23-4 is reported. Materials testing results are included in summaries on spherical insulation tests, thermal grease tests, impact tests on U-8Mo, galvanic corrosion testing of Al and Inconel 625, and tests of long term compatibility between materials used in the conversion systems. Results of safety analyses conducted for the SNAP-23A systems are included. (J.R.D.)

2402 RADIATION SOURCE. (to W. R. Grace and Co.). British Patent 1,168,037. Oct. 22, 1969. Priority date June 20, 1967, United States.

A process is given for preparing a radiation source by adding a radioisotope such as ^{144}Ce, ^{242}Cm, ^{137}Cs, ^{147}Pm, ^{210}Po, ^{238}Pu, or ^{90}Sr in liquid form to a particulate matrix material which has been prepared in the microspheroidal form by drying a sol of an inorganic oxide and then heating the radioisotope-impregnated matrix at a temperature sufficient to immobilize the radioisotope. The matrix material may be an oxide of Al, As, Bi, Mo, Nb, Pb, Re, Sb, Sn, Te, V, or Zn. The impregnated microspheres are sintered at a temperature of 1000 to 1500°C for 1 to 12 hours. An example is given for the preparation of a titanium oxide matrix and the use of strontium as the radioisotope. (J.C.W.)

2403 AEROSPACE RESEARCH AND DEVELOPMENT IN THE U. S. GOVERNMENT. 4. LIFE SUPPORT. Watanabe, D. J.; Laubach, G. E. Space/Aeronaut., 52: 81-6(July 1969).

The life support systems for future space flights may use a radioisotope as a thermal energy source. A radioisotope source would provide a steady heat supply that can be designed into the life support system, and minimize the demand on the onboard electric system. In comparison with a waste heat system now in use it is simpler and more reliable and has the advantage of being independent. In a recent study of seven life support system concepts using various combinations of energy sources, a combination of electric and radioisotopic energy was selected as optimum. The design chosen actually used three isotope sources all fueled with PuO_2: one for a central heat transfer loop to meet intermediate- and low-temperature thermal requirements, another to heat a catalytic oxidizer used in trace contaminant control, and a third for a combined water and waste management system. (BBB)

2404 PRODUCTION AND SEPARATION OF INDUSTRIALLY USEFUL ISOTOPES IN SPACE. Taylor, Theodore B. IRT (Int. Res. Technol.) Nucl. J., 1: No. 5, 14-26([1969]).

The advantages, costs, and possibilities of using a space environment for the production and separation of industrially useful radioisotopes are discussed. (L.C.L.)

2405 VALUE FUNCTION FOR MULTICOMPONENT ISOTOPE SEPARATION. Lehrer-Ilamed, Y. (Soreq Nuclear Research Centre, Yavne, Israel). J. Nucl. Energy 23: 559-67 (1969).

The mathematical analysis and the solution of the functional equation for the value function corresponding to the general asymmetrical process of separation from a multicomponent mixture is considered. (auth) (UK)

Materials Testing

Refer also to abstracts 2351, 2455, 2868, 2870, 2914, 2947, 3045, 3052, and 3807.

2406 (IEA-8) GAMMA RADIOGRAPHY. Sanchez, Wladimyr; Filho, Azor Camargo Penteado (Instituto de Energia Atomica, Sao Paulo (Brazil)). June 1967. 40p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

Gamma-radiography in industry makes possible the rejection of seriously defective materials and contributes to the improvement of their manufacture. In industry gammagraphy finds a great use in the inspection of welds, cast and riveted materials. It is also important in the laboratory for nondestructive testing of fragile articles and sealed assemblies. Since both x rays and gamma rays can fulfill this purpose, a choice has to be made between these radiation sources. There is no competition between x rays and gamma rays in nondestructive testing because both methods complement each other. The technical and economical advantages and disadvantages of both methods are discussed. In welds and castings ^{192}Ir has extremely good irradiation qualities for sheets from 6 to 50 mm thick of iron. For lighter materials ^{170}Tm and ^{169}Yb can be used. For iron thickness greater than 50 mm the defects must be located with hard gamma rays of ^{60}Co. For obtaining good pictures the following techniques are discussed: the proper selection of photographic films and choice of the correct radiation source, exposure time, prevention of secondary radiation by reflected gamma rays, the correct distance between the radiation source and film and the intensifying effect of screens. Radiographic relative sensitivity is expressed in percentages of the total thickness of the object examined is shown by IQI. (auth)

2407 (ORNL-4470, pp 118-20) NONDESTRUCTIVE TEST DEVELOPMENT. McClung, R. W. (Oak Ridge National Lab., Tenn.).

Analytical studies of eddy-current phenomena were continued including derivation of new equations, refining old derivations, and writing computer programs to use the equations to study cases of interest. Improved eddy current coils were designed and made. An infrared microscope was developed. Fabrication and measurement studies are continuing on reference standards for ultrasonic inspection. The schlieren system was improved and used in preliminary work on welds. The system for frequency analysis was improved and applied to the study of frequency effects related to several variables in ultrasonic testing. Computer programs were prepared to aid the development of graphic plots for data from x-ray attenuation experiments. Work has begun on the use of Compton backscattered radiation for the examination of coatings or claddings on reactor components. (auth)

2408 (ZJE-51) ULTRASONIC INSPECTION OF WELDS WITH MORE THAN 500 MM SIZE. Prepechal, J. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). Sept. 1969. 19p. Dep. CFSTI (U. S. Sales Only).

The ultrasonic inspection of welds with more than 500 mm in size can be carried out using most principles which are used in control of smaller welds. At the same time, new problems arise, which can be solved on present stage of crack detection in control of welds of about 1000 mm. This limit represents also the limit of electroslag welding possibilities. There is the lack of practical experience which is necessary in ultrasonic crack detection. The concepts discussed could help in further solution of this very complicated technical problem. (auth)

2409 (ZJE-52) SOME ASPECTS OF STRENGTH EVALUATION OF PRESSURE VESSELS. Gregor, J. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). Sept. 1969. 17p. Dep. CFSTI (U. S. Sales Only).

Analytical and experimental techniques for evaluating the strength of pressure vessels are described, and Czechoslovakia and ASME standards used in these techniques, particularly for the case of nuclear reactor pressure vessels, are discussed. (L.C.L.)

2410 THE COMPUTER: AN AID FOR ANALYZING AND PROCESSING CREEP-RUPTURE DATA. King, R. T.; Thomas, E. M.; McCoy, H. E. (Oak Ridge National Lab., Tenn.). J. Metals, 21: No. 11, 62-8(Nov. 1969).

Systems are described in which a computer is used as an aid for analyzing creep-rupture data. In the CADCAPS system the basic test parameters are measured as electronic signals that can be used as input information for a small on-line computer. The data can be displayed as creep (strain vs time) curves or in

numerous other forms. In present systems data collection and data processing are performed separately. The data-collection systems include manually collected data that are keypunched onto cards and electronic transducer signals that are fed through a multichannel recorder to an analog-to-digital converter, punched on paper tape, and transferred to magnetic tape. In both cases large central computers are used to process the data to obtain tabulations and plots of strain versus time for each test. Several methods for storing and sorting the creep test data are described. (auth)

2411 STUDY OF THE COATING THICKNESS MEASUREMENT BY THE METHOD OF FILTERING BACKSCATTERED BETA PARTICLES. Kiang, G. C. (Inst. of Physics, Taiwan); Lee, L. Chin. J. Phys. (Taiwan), 7: 7-14(Apr. 1969).

A theoretical deduction of the thickness measurement for coating layers by beta backscattering method is described. When a filter is used, the sensitivity for the measurement is improved, no matter whether the atomic number of the deposited layer is larger or smaller than the atom number of its base. Various thickness of aluminum and tin layers deposited separately on copper plates were measured using a thin window G-M counter, using ^{32}P as beta source and aluminum absorber as filter. Experimental results were found to confirm the theoretical deduction. (auth)

Radioactive Material Handling

Refer also to abstracts 2260, 3007, and 3052.

2412 (BARC-288) THERMAL BEHAVIOUR OF SOLID RADIOACTIVE WASTE IMMERSED IN CONDUCTIVE-CONVECTIVE MEDIA: A STUDY. Ravindranath, V.; Chandra, Keshava; Sehgal, J. D.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 25p. Dep. CFSTI (U. S. Sales Only).

A generalized mathematical model for transient and steady-state heat removal from an infinitely long cylindrical radioactive source enclosed by finite or infinite, solid or fluid medium is presented. A parametric study was made of the effects of time, source strength, diameter, and Biot group variables. The source was taken as independent of time and space coordinates in this study. A Fortran program was written and run on CDC 3600 digital computer to study the effect of the above variables on temperature profiles inside the source. Nomographs were prepared to cover a range of parameters expected to be encountered by a designer of any highly radioactive solid waste storage system. (auth)

2413 (DPSPU-69-30-9) STORAGE OF LIQUID RADIOACTIVE WASTES AT THE SAVANNAH RIVER PLANT. Girdler, R. M. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). July 1969. Contract AT(07-2)-1. 11p. (CONF-690819-2). Dep. CFSTI.

From 66th National Meeting of the American Institute of Chemical Engineers, Portland, Ore.

A discussion is presented of the management of liquid radioactive wastes at the Savannah River Plant. Complete containment and minimum volume of stored wastes are the objectives for liquid waste storage. Designs and features of the storage tanks are described. After storing in the tanks, further processing involves reducing the volume so that a minimum number of tanks are used. After the tank is full the contents must remain until the shorter half-lived fission products decay to a level that will not interfere with subsequent processing. The present practice of storing waste in tanks will continue until facilities for long-term storage are provided. (J.C.W.)

2414 (JEN-204-DMa/I-24) CONCENTRATION AND SOLIDIFICATION OF LIQUID RADIOACTIVE WASTES. LABORATORY STUDIES. Nuche Vazquez, F.; de Lora Soria, F. (Junta de Energia Nuclear, Madrid (Spain). Division de Materiales). 1969. 17p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Bench scale runs on concentration of intermediate-level radioactive wastes, and incorporation of the concentrates in asphalt are described. The feasibility of the process has been demonstrated, with a maximum incorporation of 60% of salts into the asphaltic matrix and a volume reduction factor of 10. (auth)

2415 (K-TL-37) SUPPLEMENTAL RADIATION SHIELD FOR 1100-CURIE COBALT SHIPMENT. Newlon, C. E.; Bailey, J. C. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 23 May 1969. Contract W-7405-eng-26. 21p. Dep. CFSTI.

The design and shielding performance of a supplemental radiation shield which will support and contain four types of irradiated Bonus reactor control rods within a 35 ton lead-filled ATCOR cask used to transport the control rods from Puerto Rico to a disposal area in the continental U.S. are described. The supplemental shield is a disposable unit which fits inside the shipping cask and consists of a $\frac{3}{4}$-in.-thick cylindrical steel weldment $35\frac{1}{2}$ in. in dia and 74 in. long, and contains an internal 2 in.-thick-steel storage box whose inside dimensions are $11\frac{1}{2}$ by $11\frac{1}{2}$ by $68\frac{3}{4}$ in. The maximum radiation protection provided by the ATCOR shipping cask with the new supplemental shield is approximately equivalent to that of an 8 in. thick lead shield under conditions of design loading; up to 1000 Ci of ^{60}Co in the 2 in. thick steel box; and up to 100 Ci of ^{60}Co in the annular section of the shield. It is concluded that the ATCOR shipping cask with the supplemental radiation shield appears to meet all DOT and AEC safety requirements for shipment of radioactive control rods containing 1100 Ci of ^{60}Co. (L.C.L.)

2416 (NP-18041) NOTES FOR THE GUIDANCE OF PERSONS CONCERNED IN THE CARRIAGE OF RADIOACTIVE SUBSTANCES BY SEA. (Department of Shipping and Transport (Australia)). June 1969. 45p. Dep. CFSTI (U. S. Sales Only).

Information is presented to assist persons concerned with the packing, storage, and transport of radioactive cargoes in ships. Australian legal requirements for these activities are described. The regulations themselves are not included. Descriptions are given of radioactive materials categories, types of packaging, labeling procedures, shipping document requirements, and personnel safety procedures. (L.C.L.)

2417 (ORNL-4470, pp 211) ABSORBER MATERIALS FOR SO_2 FROM FLUE GAS. Ernst, W. S. Jr. (Oak Ridge National Lab., Tenn.).

Pollution control studies of the reaction of SO_2 with $NaAlO_2$ granules and subsequent regeneration in H_2 showed that cyclic phase transformations did not cause breakup of the spheres. Extensive breakup was observed on heating if the $NaAlO_2$ was allowed to absorb moisture. (auth)

2418 (ORNL-TM-2712) FEASIBILITY STUDY OF REMOTE CUTTING AND WELDING FOR NUCLEAR PLANT MAINTENANCE. Holz, Peter P. (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 53p. Dep. CFSTI.

Activities in a program to adapt the Air Force cut and weld system for orbital vehicles, to remote reactor maintenance, are described. The orbital system includes a carriage, interchangeable modules for machining or W-arc welding, a weld programmer, and a power supply. Drawings and components for nonnuclear testing have been assembled and operations such as on-pipe carriage clamping, cutting and beveling using one orbital head, changing heads, and welding were completed. Factors related to radioactive system maintenance are discussed. Progress of the feasibility study is summarized. A long range program is proposed for development of a complete remote maintenance system. (J.R.D.)

2419 (WASH-1140) SAFEGUARDS SYSTEMS ANALYSIS OF NUCLEAR FUEL CYCLES. (Office of Safeguards and Materials Management (AEC), Washington, D. C.). Oct. 1, 1969. 312p. Dep. GPO $2.25.

Seven papers on safeguards systems analysis of nuclear fuel cycles are presented. Separate abstracts were prepared for each. (L.C.L.)

For abstracts of individual papers see: 2420–2426.

2420 (WASH-1140, pp 1-28) U. S. SAFEGUARDS SYSTEMS STUDIES. Kouts, Herbert J. (Brookhaven National Lab., Upton, N. Y.); Williams, James M. (Office of Safeguards and Materials Management (AEC), Washington, D. C.).

The application of systems analysis to safeguards systems to assure that special nuclear materials are not diverted to unauthorized uses is described. The basic steps in both system analysis and in safeguards procedures, particularly in nuclear materials accounting, are discussed. The need for developing the analytical models required to characterize the nuclear fuel cycle and the materials accounting procedures and to determine how, where, and in what magnitude losses can occur during the handling of nuclear materials is emphasized. (L.C.L.)

2421 (WASH-1140, pp 29-73) SAFEGUARDS ACCOUNTABILITY ANALYSIS IN A NUCLEAR FUEL PROCESSING PLANT. (National Bureau of Standards, Washington, D. C.).

A procedure is described for estimating the unidentified and unmeasured losses that occur unintentionally in a nuclear fuel fabrication plant, and for applying these estimates to evaluations of materials unaccounted for (MUF). Variations of MUF derived from materials balance accounts are examined and attempts are made to isolate the various components of MUF for a selected nuclear processing operation. (L.C.L.)

2422 (WASH-1140, pp 75-114) CAPABILITY OF A TYPICAL MATERIAL BALANCE ACCOUNTING SYSTEM FOR A CHEMICAL PROCESSING PLANT. Schneider, R. A.; Granquist,

D. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A material balance model was constructed for a commercial chemical processing facility. A Purex-type flow-sheet was assumed for a plant operating on a clean plant-to-clean-plant basis. It was further assumed that a campaign consists of 40 tonnes of irradiated low enriched uranium containing 10,000 grams/tonne of plutonium. A process waste loss of 1% of input and a between-campaign inventory of 0.5% of input were assumed. Estimates of the random and systematic errors associated with sampling, analysis, volume and weight measurements were made for all individual batch measurements and shipper-receiver measurements. These estimates of error were combined by conventional techniques of error propagation to yield estimates of the variance of materials unaccounted for (MUF). Two basic models were developed—one a capability model and one a performance model. The capability model represents the best performance (the smallest error) that the measurement system is theoretically capable of achieving in an operating environment. The performance model represents what might more generally be expected in practice from a high quality measurement system. The effectiveness of material accounting in detecting a loss of material during a chemical processing campaign was determined. The performance indices in terms of relative standard deviation (σ) are σ_{MUF}, Pu = 0.31% and 0.62% while σ_{MUF}, U = 0.25% and 0.52% respectively for the capability and performance models. Eighty percent of the time the capability model would signal the need for an investigation if 0.77% of the plutonium or, if 0.63% of the uranium in a campaign were diverted. Similar values for the performance model are 1.55% of the plutonium or 1.30% of the uranium. The limiting factor in reducing the variance of MUF is the systematic error associated with the analysis, sampling, and volume measurement of inputs and products. The contributions of inventory and waste measurements are small in the example because of the relatively small quantities assumed for the model. When waste losses become of the order of 2 to 3% of input, waste measurement errors become an important contribution to the variance of MUF. About 90% of the variance of MUF in the examples considered here is due to systematic error. Because of the dominant role of systematic error, successive relative MUFs, when due to measurement error alone and not other causes, tend to be relatively constant around some non-zero value. (auth)

2423 (WASH–1140, pp 115-62) A DETAILED ANALYSIS OF THE SAFEGUARDS CAPABILITIES OF MATERIAL BALANCE ACCOUNTING SYSTEMS IN THE LOW ENRICHED UO_2 CONVERSION AND FABRICATION SECTORS OF THE COMMERCIAL FUEL CYCLE. Wirfs, L. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A detailed analysis was made of the safeguard capabilities of materials balance accounting systems applied to the UO_2 conversion and fabrication phases of the commercial fuel cycle to determine how much ^{235}U loss during these processes could be attributed to measurement errors, lack of loss detection capabilities, and inventory methods. It was concluded that current capabilities could be upgraded significantly by better quality control, more accurate measuring methods, and improved physical inventory practices, and that, ultimately, the safeguard capabilities depend on the control of systematic errors in material transfer measurements and control of random errors in inventory measurements. (L.C.L.)

2424 (WASH–1140, pp 163-96) THE NUCLEAR MATERIALS MANAGEMENT SUBSYSTEM OF THE U.S.A.E.C.'S MANAGEMENT INFORMATION SYSTEM. Weber, Russell E. (Office of Safeguards and Materials Management (AEC), Washington, D. C.).

The nuclear materials management subsystem of the USAEC's Management Information System is automated to receive and arrange information from 900 facilities that receive nuclear material from, or within, the U. S. Input to the subsystem includes details on the form, location, enrichment, and quantity of holdings at each facility. Materials balance summaries report each transfer of material, losses, materials unaccounted for, and status of scrap inventories. The formats used for reporting this information are illustrated as are the computer printout forms for materials inventories. Three areas of the subsystem which represent the safeguards chain are the Transactions Journal, Materials Balance Report, and the Composition of Ending Inventory. These can be used in the computer program to develop working papers which supply data on conditions at any one of the input facilities at a given time, and to predict inventory conditions at a given time and place. (L.C.L.)

2425 (WASH–1140, pp 197-231) ROLE OF STATISTICS IN SAFEGUARDS. Stewart, K. B.; Jaech, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Specific uses of statistics in programs for safeguarding nuclear materials, and the importance of applying modern statistical techniques to safeguards problems are discussed. It was concluded that safeguards data should be collected in such a manner as to obtain the maximum valid statistical information, that materials unaccounted for (MUF) accuracy can be improved by applying sophisticated data analysis methods, that data other than MUF can be used to identify and locate materials losses, and that the theory of games could well be applied to the control of nuclear materials. (L.C.L.)

2426 (WASH–1140, pp 233-312) STATISTICAL TECHNIQUES FOR ENHANCING THE ROLE OF MATERIAL BALANCE ACCOUNTING IN SAFEGUARDS. Stewart, K. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Statistical techniques for improving the effectiveness that the role of material balance accounting plays in safeguards are discussed as two topics. The first deals with the creation of statistics which have the most power to determine that a loss has occurred within a material balance area by more fully using the intrinsic features of the flow of material through a material balance area, and the second is directed at developing procedures for determining where to spend the sampling and measurement dollar to obtain better estimates of the amount of material in a unit, in a stratum, and in an inventory. The concept of material unaccounted for (MUF) is described, and a mathematical model is developed to illustrate the parameters involved in MUF statistics. Three statistical methods for inventory verification are discussed. The first uses standard MUF procedures for short term control, the second uses standard MUF procedures for long term control, and the third uses existing data but new and more sensitive statistical procedures for detecting material losses. The three methods are compared for the cases of an isolated incident of material diversion and for a systematic long term diversion. Finally, the best ways of acquiring and using data for inventory verification are discussed. (L.C.L.)

2427 CONTROL OF FISSIONABLE MATERIALS: POSSIBILITY OF FRAUD. Malleroy, Antoine. Atomes (Paris), 24: 469-71 (July-Aug. 1969). (In French).

Article III of the nuclear nonproliferation treaty provides that signatories must accept the control of the IAEA and receive its inspectors; Euratom has had obligatory control since 1958. The methods of application of security regulations deserve more attention. Obtaining Pu outside of usual channels is possible because of Pu production in all power plants, so that available Pu is directly tied to the number of nuclear power plants. This quantity would be 10,750 kg for the western world in 1975. Many opportunities for fraud in the reporting of Pu from plants exists: the composition of the fuel element, its time in the reactor, its position, its combustion yield, and its retreatment. A 5% fraud in Germany would give that country 90 kg Pu per year by 1975; other figures may be evaluated for Italy, Sweden, India, Israel, Egypt, or Pakistan. Inspectors of the AEC, IAEA, and Euratom have developed special control techniques; the problem of monitoring retreatment procedures is still a severe one. (BBB)

2428 SPECTROPHOTOMETER GLOVE BOX (Aug. 11, 1967) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1926).

3 drawings.

A glove box and absorption-cell compartment, designed to be used with a Cary spectrophotometer, permits measurements on highly radioactive alpha-emitting solutions. A transfer box, with a polyurethane bellows attached to the bottom, is fixed to the side of a glove box at the top. The absorption cell containing the radioactive solution is positioned in a metal compartment provided with quartz windows. The spectrophotometer cell compartment is attached to the bellows. Complete containment is maintained within the cell compartment and the glove box. The plexiglass transfer box has glove ports located on the front and the side. (For details see TID-4100 Suppl. 55.) (F.S.)

2429 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep., 10: 369-73(Aug. 1969).

A summary is given of environmental radiation data for the area near the Feed Materials Production Center, Fernald, Ohio taken during July through December 1968 and near the National Reactor Testing Station, Idaho Falls, Idaho taken during the first six months of 1968. (L.C.L.)

2430 A 5-YEAR SUMMARY OF THE REGULATORY CONTROL OF RADIOACTIVE MATERIAL IN ARKANSAS. Wilson, E. F.; Snellings, D. D. Jr. (Arkansas State Dept. of Health, Little Rock). Radiol. Health Data Rep., 10: 341-5(Aug. 1969).

The Arkansas State Department of Health, Division of Radiological Health, in assuming the regulatory control of radioactive material on July 1, 1963, instituted a program of licensing and inspection of all users of regulated material with the ultimate

goal of preventing, if possible, or reducing to an acceptable level, the exposure of ionizing radiation. A summary of regulatory activities of the Division of Radiological Health from 1964 through 1968 is reported. The early (1964) regulatory inspections did not include sufficient data pertaining to the occupational exposure of individuals to radiation; however, the noted deficiencies of records and radiation safety are well documented. In early 1967, the Division of Radiological Health prepared all previous data for electronic data processing, and currently all regulatory inspections, as well as licensing activities, are prepared for electronic data processing on a routine basis. (auth)

2431 RADIOACTIVE WASTES IN SALT MINES. McClain, W. C.; Bradshaw, R. L. (Oak Ridge National Lab., Tenn.). Mines Mag., 59: 11-14(Aug. 1969).

The concept and procedures for using salt mines for the disposal of high-level solidified radioactive wastes are discussed, and a demonstration experiment conducted at an inactive salt mine at Lyons, Kansas from November 1965 to October 1967 is described. Irradiated fuel assemblies from the Engineering Test Reactor at Idaho Falls were used to provide sources of intense radioactivity while electric heaters supplemented the decay heat generated by wastes. The results indicated that burial in salt mines is one of the best, if not the best, of currently available methods for high-level solidified waste disposal. (L.C.L.)

2432 WASTE DISPOSAL SYSTEMS IN THE FIRST NUCLEAR-POWERED SHIP. Hayashi, Tadamasa (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen, No. 67, 1666-72(May 1969). (In Japanese).

In the first nuclear-powered ship, radioactive wastes are temporarily stored within the ship without treatment. Upon entry into the harbor, they are transferred to the treatment facilities on land where they are treated adequately. As in other atomic ships, the radioactive wastes occurring in the ship are solid, liquid and gaseous. The procedures of handling, mostly in the ship but also on land, are described. Handling of radioactive solid wastes includes filters in the radiation-control areas, ion-exchange resins in the coolant-purifying system, paper towels and cloths in the radiation-control areas, and contaminated equipment. Radioactive liquid wastes include chemically pure water and water containing impurities. Radioactive gaseous wastes are gases in the liquid wastes and exhaust air in the control-area ventilation. Ion-exchange towers for purifying coolant water during reactor operation, ion-exchange towers for feeding coolant water, and sampling systems are also described. (NSA of Japan)

2433 TRANSPORTING RADIOACTIVE MATERIAL. Shappert, L. B. (Oak Ridge National Lab., Tenn.). Oak Ridge Nat. Lab. Rev., 3: No. 1, 26-32(Summer 1969).

With increased nuclear power plant construction, spent fuel and radioisotope transport will increase. Economics is always important, but in shipping radioactive materials, the relationship to safety is always considered. Regulations are implemented by the Atomic Energy Commission and the Department of Transportation, both United States agencies. The transport container must not release any activity, permit excessive dose rates around the container, or sustain a nuclear chain reaction if fissile material is being transported. Mechanical accidents that any container must withstand before being approved include free drop, puncture, thermal, and water immersion for packages containing fissile materials. Types of sources shipped and containers used are discussed, along with the container research program at Oak Ridge National Laboratory. (J.C.W.)

2434 DELAYED-NEUTRON MULTIPLICATION IN FAR-SUBCRITICAL SYSTEMS. Lee, Clarence E.; Masters, Christopher F.; Turner, G. David (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 38: 114-24(Nov. 1969).

Three methods are presented for calculating the multiplication of the delayed-neutron response which occurs in far-subcritical samples of fissionable material irradiated by an external neutron source: a three-energy group analytic expression; the zero prompt-lifetime approximation in conjunction with a one-dimensional steady-state transport theory code; and a three-dimensional time-dependent Monte Carlo code. The accuracy and limitations of the calculational techniques are demonstrated by a comparison with experimental measurements. (auth)

2435 METHOD OF CHANGING GLOVES IN A CONTROLLED ENVIRONMENT BOX. Woolsey, Joseph W. (to U. S. Atomic Energy Commission). U. S. Patent 3,475,808. Nov. 4, 1969.

A method is given for changing gloves in a box, which consists of mounting a new glove on a new mounting ring, loosening the set screws on the old mounting ring, and inserting the new glove inside the old glove, inserting a guide ring aligned so that the set screws of the new mounting ring are positioned in grooves of the guide ring, exerting force on a push ring inside the guide ring and against the old glove ring so that the old glove and mounting ring fall into the box, removing the guide ring and push ring, and tightening the set screws in the new mounting ring. (AEC)

2436 HAZARDS CONNECTED WITH THE HANDLING OF TRANSURANIUM ELEMENTS AND METHODS USED FOR THE PROTECTION OF PERSONNEL. Vaane, J. P. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). Actinides Rev.: 1: 337-70(Sept 1969).

The general safety problems connected with the handling of transuranium elements are reviewed. Radiation properties are discussed. Special emphasis is placed on the problem of air contamination and inhalation hazards. Methods of safe handling and radiation control are also discussed. (79 references) (J.G.B.)

Vacuum Engineering

2437 (SLAC-Trans-101) DESIGN AND CALCULATION OF MAGNETIC-DISCHARGE PUMPS. Malev, M. D.; Trakhtenberg, E. M. Translated for Stanford Linear Accelerator Center, Calif., from Preprint No. 280. 30p. Dep. CFSTI.

The operating principle and functional characteristics of a magnetic-discharge pump are described. On the basis of previously obtained empirical formulas for the evacuation rate and minimum pump pressure, a method is proposed for calculating the basic dimensions of a magnetic-discharge pump for given values of the evacuation rate, working pressure and magnetic-field strength. The influence of the required residual-atmosphere composition and range of working pressures on the design of the basic pump elements was studied, and some practical recommendations for designing built-in magnetic-discharge pumps are given. (auth)

2438 TURBO-MOLECULAR PUMPS IN NUCLEAR ENGINEERING. Henning, J. (Arthur Pfeiffer Hochvakuumtechnik GmbH, Wetzlar, Ger.). Kerntechnik, 11: 590(Sept.-Oct. 1969). (In German).

Vacuum problems connected with the application of accelerators are briefly mentioned. Construction and properties of the turbo-molecular pump are discussed with emphasis on the achievement of high and ultrahigh vacuum free of hydrocarbons. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 2871, 3055, 3915, and 3916.

General Detectors and Monitors

Refer also to abstracts 2730, 3054, and 3795.

2439 (AEEW-M-912) PROPORTIONAL COUNTERS FOR MEASURING ^{239}Pu 'IN VIVO': THE CHOICE OF COUNTING GAS AND THE USE OF PULSE SHAPE DISCRIMINATION TECHNIQUES. Pike, R. A.; Ramsden, D. (Atomic Energy Establishment, Winfrith (England)). Aug. 1969. 15p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

The system for determining insoluble plutonium in vivo, now in routine use at A.E.E. Winfrith, has a limit of detection of the order of 4 nCi plutonium-239. The method of reducing background by using pulse shape discrimination techniques whilst retaining a high detection efficiency is described. The choice of a counting gas mixture to obtain optimum performance is discussed as are the techniques of gas handling. (auth)

2440 (BNL-14058) OVERLOAD RECOVERY CIRCUIT FOR CHARGE AMPLIFIERS. Radeka, Veljko (Brookhaven National Lab., Upton, N. Y.). [1969]. 12p. (CONF-691017-1). Dep. CFSTI.

From 16th Nuclear Science Symposium, San Francisco, Calif.

The operation of low noise charge preamplifiers under high instantaneous pulse rates or bursts is considered. An overload recovery circuit employing a field-effect transistor as the switch for the recovery current is described. The overload charge generated in the detector by the radiation burst in a time short compared to the small signal resolving time of the spectrometer may be 10^5 or more times larger than the charge due to a single particle to be measured between the bursts. The recovery time of the charge amplifier with the recovery circuit is less than 10 μsec. With a conventional amplifier-filter, the recovery time of the system to within the noise level is 50 to 100 μsec. The increase in noise due to the recovery circuit corresponds to an increase in the input capacitance of the charge amplifier of 2 pF. (auth)

2441 (CEA-CONF-1294) POSSIBILITIES OF A GAS DETECTOR WITH THREE ELECTRODES IN THE DOMAIN OF THE VISUALIZATION OF X RAYS. Roux, G.; Lansiart, A.; Morucci, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Saludjian, P. (Centre National de la Recherche Scientifique [Paris (France)]). [1968]. 8p. (In French). (CONF-690534-1). Dep. CFSTI (U. S. Sales Only).

From Conference on Analytical Methods for X-Rays, Montpellier, France.

A general description is given of the characteristics and operational procedure of three-electrode gas detectors operating in the spark and avalanche regimes. The application of these detectors to the recording of x-ray diffraction diagrams at small angles is described. The properties of the gas detector used in this application are described with respect to the spark dimensions and the spatial definition. A comparison of the performance of the gas detector with that of an x-ray photographic film shows that the gas detector assures a minimum exposure compatible with statistical needs. The gas detector also allows dynamic studies connected, for example, with temperature or hygrometry The dead time of the detector, used in spark regime, does not permit the correct recording of diffraction diagrams where the x-ray intensity for the whole of the diagram is higher than 1000 quanta/sec. This defect does not apply to the detector used in avalanche regime. (J.S.R.)

2442 (CISE-R-96) A DEVICE FOR FINE FLUX DISTRIBUTION MEASUREMENT AND A CODE FOR COUNTS CORRECTIONS. Topical Report No. 1. Accinni, F.; Pirovano, B. (Centro Informazioni Studi Esperienze, Milan (Italy)). Jan. 1964. Contract 005-63-7-NTRI. 27p. Dep. CFSTI (U. S. Sales Only).

A device is described which is designed to perform fine flux distribution measurements of thermal neutrons by means of activation of wires. The tests of the performance and resolution of the instrument are also reported. A code for the elaboration of raw data from counting with G.M., or other nuclear detectors, is then described. (auth)

2443 (CLOR-76/D) STATIC GAMMA BACKGROUND MONITOR FOR IDENTIFICATION OF CONTAMINATION AND DOSE-RATE IN THE CASE OF DISPERSAL RADIONUCLIDES TO THE ATMOSPHERE. Pensko, Jerzy; Jagielak, Jan (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1969. 39p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The construction of a static scintillation gamma background monitor and method of measurement, which can be used for identification of environmental radioactive contamination in the atmosphere and soil, is described. The dose-rate of environmental gamma radiation can be continuously measured and the increase of the dose-rate of about 10% can be detected. This method should be useful in the emergency associated with the uncontrolled dispersal of radionuclides to the atmosphere. (auth)

2444 (IEA-145) FISSION CHAMBERS: CONSTRUCTION AND CHARACTERISTICS. Mafra, Olga Y.; Bianchini, Fernando G. (Instituto de Energia Atomica, Sao Paulo (Brazil)). June 1967. 19p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

A technical description of the electrodeposition techniques of uranium and thorium oxides on aluminum plates, to be used as electrodes of a fission chamber is presented. The maximum thickness of the coating obtained is 2.5 and 1.5 mg/cm^2 of uranium and thorium oxides respectively. These plates were used as the collecting electrodes of a gas flow ionization chamber; the filling gas being a mixture of 97% of argon and 3% of nitrogen. Graphs showing the influence of oxygen and water vapor traces on the electron collection, and the pulse height distribution versus electrode separation are presented. The data related to the operation of the detector as an ionization chamber are discussed. (auth)

2445 (INR-1064) ANALYSIS OF DETECTION BY NEON HODOSCOPE. Jatczak, Jerzy (Institute of Nuclear Research, Warsaw (Poland)). 1969. 36p. Dep. CFSTI (U. S. Sales Only).

The detection of EAS particles by an array of hodoscoped Conversi detectors (neon flash-tubes) is analyzed. The average number of Conversi detectors hit by a single particle is found as a function of the angle the direction of the particle makes with the vertical. The probability of the particle causing detectors to flash is calculated as a function of that angle. The relation between the layer efficiency of the hodoscope and the zenith angle of the shower axis is derived. (auth)

2446 (INR-P-1074) LOGARITHMIC RATEMETER WITH SCINTILLATION HEAD FOR γ, β, AND n RADIATION MEASUREMENTS IN REACTOR DOSIMETRY SYSTEMS. Ostrovskii, A. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 14p. (In Russian). Dep. CFSTI (U. S. Sales Only).

An instrument designed for γ, β, and neutron radiation measurements in a reactor environment is described. The counting rate of pulses coming from scintillation detectors is measured in logarithmic scale, in two ranges: 10^{-1} to 10^4p/s and 10^0 to 10^5p/s. The scintillation detector allows for operation at long distances from the measuring panel. All measuring circuits including the pulse amplifier, discriminator, pulse forming circuit for log ratemeter, two log ratemeter assemblies (diode pumps), dc amplifier, trip circuit, stabilized H. T. supply, and low voltage stabilizers for the measuring circuits are situated in the main panel. The instrument is fed from ac mains, 220 v, 50 Hz. The circuits are described and some data on the instrument's properties are given. The instrument has been designed in IBJ-Swierk and is being produced in small series in the Institute's production department. (auth)

2447 (JPRS-49167) INSTRUMENT FOR STUDYING COSMIC RADIATION AT ALTITUDES OF 200 TO 400 KM. Maduev, V. L.; Makhmudov, B. M.; Pisarenko, N. F. Translated from Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 4, 79-82(1969). 6p. CFSTI.

A system of detectors, including a tissue-equivalent ionization counter, a Geiger counter, a scintillation counter, and seven end-window halogen counters, is described for measuring absorbed doses and dose rates, the energy spectrum of protons from 0.5 to 10 MeV, and the energy spectrum of electrons from 60 to 500 keV at altitudes of 200 to 400 km. (W.H.K.)

2448 (LA-4262) DOOR ALARM AND INTERLOCK SYSTEM AT THE LOS ALAMOS TANDEM ACCELERATOR FACILITY. Seitz, Thomas P.; Lang, Harold J.; Henkel, Richard L. (Los Alamos Scientific Lab., N. Mex.). 11 Sep 1969. Contract W-7405-eng-36. 6p. Dep. CFSTI.

Like most accelerator facilities, the Los Alamos tandem accelerator facility was designed to provide adequate radiation shielding to personnel. To permit maximum use of the facility during accelerator operation, a door alarm and interlock system was designed to control access to areas of possible radiation.

The system provides a programmed method of selecting various control conditions for entrances to radiation areas, depending upon the amount of radiation in the area and the amount of control desired. This enables personnel to work safely in given areas while experiments are in progress in other areas. (auth)

2449 (MLM-1681(tr)) THE USE OF THE ASSOCIATED PARTICLE METHOD FOR DETERMINING DETECTOR EFFICIENCY OF SCINTILLATION DETECTORS FOR NEUTRONS FROM THE D(d,n)^{3}He REACTION. Greil, A.; Truetzschler, K. Translated for Mound Lab., Miamisburg, Ohio, from Kernenergie, 12: 68-70(1969). 9p. Dep. CFSTI.

The associated particle method is described, along with the irregularities of the D(d,n)^{3}He reaction. A surface barrier detector (SB detector) served as the ^{3}He detector. An SEV K14FS50 with a plastic scintillator was used for neutron analysis. Use of the associated particle method with this equipment provides an effective evaluation of the neutron detector for 2.5 MeV neutrons. (auth)

2450 (ORNL-TM-2597) SMOOTHIE: A PROGRAM FOR SMOOTHING O5S HISTOGRAM OUTPUT. Santoro, R. T.; Zobel, W.; Textor, R. E. (Oak Ridge National Lab., Tenn.). Nov. 5, 1969. 31p. Dep. CFSTI.

Program SMOOTHIE is an auxiliary routine written to smooth O5S histogram data using Gaussian functions with parameters specified by the user. A plot of each smoothed pulse-height distribution is produced along with a listing of the differential and integral neutron detection efficiency as a function of the light output. Program SMOOTHIE is written in FORTRAN IV. (auth)

2451 (PHS-999-RH-38) SOME PHYSICAL FACTORS AFFECTING RADIOGRAPHIC IMAGE QUALITY: THEIR THEORETICAL BASIS AND MEASUREMENT. Bates, Lloyd M. (Johns Hopkins Univ., Baltimore, Md. Bureau of Radiological Health, Rockville, Md.). June 30, 1966. Contract SAph 76496. 101p. GPO Free.

The medical diagnostic process involved in determining the pathological condition of a patient made on the basis of available roentgenological information is reviewed. In diagnostic roentgenology, information relating to the patient is made available through the medium of x rays and is displayed in the form of a visual image. The final step in information acquisition is the detection and recognition by the roentgenologist of patterns in the image. A program of work on the physics of diagnostic roentgenology was established at the Johns Hopkins University. The general purpose of this program is threefold: (1) to carry out a fundamental study of the parameters of an imaging system that affect image quality; (2) to devise methods to measure these parameters; and (3) to make available to the field of radiology the results of these measurements on apparatus currently available in the United States. The manner in which the measurements were analyzed and a summary of the characteristics of radiographic films and screens currently available in the United States are included. Detailed data from the measurements are not included because of their bulk; these data will be published as a separate report in the Environmental Health Series. A set of tables and curves are presented in the appendix to indicate the format in which the data will be published. (auth)

2452 (SRRC-31/69) COMPARISON OF METHODS TO ASSESS GEOMETRICAL VARIATIONS OF THE COUNTING-RATE IN WHOLE-BODY MONITORS. Boddy, Keith; Holmes, Barbara M.; King, Priscilla C.; Dunn, Donald M. (Scottish Research Reactor Centre, East Kilbride (Scotland)). Dec. 1968. 27p. Dep. CFSTI (U. S. Sales Only).

The variation in the counting-rate of a whole-body monitor, due to redistribution of an administered isotope in the body, has been investigated by three methods. Point sources in simple water phantoms including a life-like phantom containing simulated organs and human subjects were studied. The results from all methods were in reasonable agreement. The point source study showed that changes in the depth of the isotope in the body caused greater variation of the counting-rate than changes in longitudinal or lateral position, and realistic quantitative estimates of the variation were obtained. It is suggested that this simple method might be a suitable basis for inter-laboratory comparisons. Confirmatory data on human subjects are supplied by the routine use of the whole-body monitor. It was found that the use of an elaborate phantom, which may be expensive to purchase, is comparatively time-consuming and is probably unnecessary. (auth)

2453 (UCRL-71787) DOUBLE-DRIFT THIN-WINDOW PLANAR Ge(Li) DETECTORS. Okubo, Dan (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 16, 1969. 8p. (CONF-691017-2). Dep. CFSTI.

From 16th Nuclear Science Symposium, San Francisco, Calif.

An improved method for fabricating a thin-window planar detector was developed at Lawrence Radiation Laboratory, Livermore. This detector is designed to analyze spectra of low-energy as well as high-energy gamma and x rays. The detector has a planar configuration with a relatively large gold surface barrier entry window. The main advantage of this detector is its faster drifting time coupled with minimum waste of material. The fabrication of this detector employed the best concepts of Goulding's thin-window detector and Mann's double-drifted detector. In Goulding's model, the geometry of the detector is cut so that following drift, a P-type ring remains around the base of the detector. Gold is then evaporated on the intrinsic region surrounded by the P-type ring, thereby forming the thin entry window. The double-drift, thin-window planar method is employed both to create this P-ring without extensive cutting, and to increase the effective compensation rate. (W.H.K.)

2454 (UCRL-71822) INFRARED EVALUATION TECHNIQUES FOR Ge(Li) DETECTORS. Armantrout, G. A. (California Univ., Livermore. Lawrence Radiation Lab.). 14 Oct 1969. 8p. (CONF-691017-4). Dep. CFSTI.

From 16th Nuclear Science Symposium, San Francisco, Calif.

The types of Ge(Li) detector spectrum degradation due to trapping effects are first considered, and a model is presented which explains this degradation in terms of specific phenomena. Then two detector evaluation techniques which utilize infrared light for studying these phenomena are outlined and the significant results obtained using these techniques are presented. The infrared absorption measurement yields information concerning apparent strain in the crystal which can be related to localized trapping effects in the detector. The detector response to monochromatic infrared light determines the presence of localized lithium precipitation (a major cause of spectrum tailing) and permits a quantitative measurement of the important carrier traps in germanium such as the lithium-defect trap, copper, nickel, and iron. Utilizing these measurements, it is possible to completely characterize the performance of a crystal and determine the source of detector degradation in one day. Very good correlation is consistently obtained. (auth)

2455 THE PHOTOGRAPHIC ACTION OF IONIZING RADIATIONS IN DOSIMETRY AND MEDICAL, INDUSTRIAL, NEUTRON, AUTO- AND MICRORADIOGRAPHY. Herz, R. H. Wiley Series on Photographic Science and Technology and the Graphic Arts. New York, John Wiley and Sons, Inc., 1969. 647p. $22.50.

This is the first comprehensive account of how and why ionizing radiations, such as x- and gamma rays, electrons, alpha particles, protons, and neutrons affect the photographic emulsion. With an introduction on x-ray and particle physics, the first part of the book gives an account of the theoretical and experimental fundamentals of the photographic response to ionizing radiations. The second part covers most of the essential aspects of the many photographic applications of ionizing radiations with the aim of improving the image quality in medical and industrial radiography, in neutron, electron, auto- and microradiography, and of achieving the optimum utilization of photographic emulsions in dosimetry. The main purpose of the book is to provide the reader with an understanding of the different processes involved and to guide him in achieving an efficient use of the hidden properties of the photographic emulsion. (auth)

2456 A SIMPLE ACOUSTICAL RADIATION WARNING DEVICE. Fox, Johannes M.; Hollandt, Heinrich (Institut fuer Strahlenforschung, Luebeck). Atompraxis, 15: 338-40(Sept.-Oct. 1969). (In German).

Technical details and a description of the function of a simple acoustical warning device against radiation is presented. This warning device is especially suited to be built by workshops of research institutes. (auth)

2457 USE OF NaI(Tl) TABLETS IN COUNTERS RECORDING γ-RADIATION IN THE PLATEAU REGIME. Vedekhin, A. F.; Balugina, N. M.; Pavlov, Yu. P. Geofiz. Appl., No. 35, 65-9 (1968). (In Russian).

It is shown experimentally that decreasing the thickness of the NaI(Tl) tablet to 1 mm leads to a 40–50 percent decrease in light output and to some deterioration in resolving power. In all cases examined, a plateau is observed in the counting curve of the counter with the FEU-35 photoelectric cathode, whose extent and slope is recorded both from the light output of the tablet and from the energy of the radiation. As the light output of the crystals increases, the plateau sector shifts toward lower intensities while retaining its relative extent. (Geophys. Abstr.)

2458 A WHOLE-BODY COUNTER WITH AN INVARIANT RESPONSE TO RADIONUCLIDE DISTRIBUTION AND BODY SIZE.

Cohn, S. H.; Dombrowski, C. S.; Pate, H. R.; Robertson, J. S. (Brookhaven National Lab., Upton, N. Y.). Phys. Med. Biol., 14: 645-58(Oct. 1969).

The operation and characteristics of the Brookhaven 54-detector whole-body counter and its associated computer facility are described. The counter is unique in that it incorporates the following properties: high sensitivity and spectral resolution, relative invariance of counting response to radionuclide distribution and body size of subject, and the ability to provide data on rapidly-translocating short-lived radionuclides. On the basis of the response of the individual detectors to a broad-beam source of ^{137}Cs, it is possible to obtain, empirically, correction factors for geometry and for absorption for each subject. The accuracy and precision of the in vivo measurements performed with this counter are presented for several clinical studies. (auth)

2459 PROBLEMS ON DISCRIMINATION OF NEUTRON AND GAMMA RAY IN A LIQUID SCINTILLATOR. Tawara, Hiroyuki; Wakuta, Yoshihisa (Kyushu Univ., Fukuoka). Kyushu Daigaku Kogaku Shuho, 42: No. 2, 85-9(Mar. 1969). (In Japanese).

Discrimination of neutrons and gamma rays using a Batchelor–Owen system is examined. Neutron detectors were 2″ and 5″ liquid scintillators NE 213 combined with the photomultiplier 56 AVP. Neutrons with energies of 2.5 MeV from the $D(d,n)^3He$ reaction and gamma rays with mean energies of 1.2 MeV from ^{60}Co were used in the experiment. The output pulse from the photomultiplier was first cut off the negative swing with a diode, and then off its tail with a time gate. This processing allows lowering the bias level of the discriminator. Discrimination characteristics were measured with varying dynode-anode voltage of the discriminator. Particle energy was measured with a photomultiplier XP 1040. With the 2″ NE 213, better discrimination was obtained for higher voltages, and with the 5″ NE 213, best results were obtained at about 5 volts. The 2″ NE 213 was better for neutron-gamma ray discrimination than the 5″ NE 213, and the pulse height of the 2″ NE 213 was about twice as high as the 5″ NE 213. The time gate of 1.0 μsec was most suitable for low energy neutrons. Technical details such as light guides, coating and sealing of the scintillator, etc., are described. (NSA of Japan)

2460 METHOD AND APPARATUS FOR ANALYSING RADIOACTIVE AEROSOLS. Antony, M. D.; Meudon, J. D.; Bourg la Reine, H. J.; Malakoff, J. P. (to Commissariat a l'Energie Atomique). Canadian Patent 811,242. Priority date June 28, 1965, France.

The apparatus consists of a filter strip, a motor for moving it past an aperture, means for providing a flow of air through the filter strip and aperture, a detector for measuring the radioactive particles deposited on the strip and an electromechanical recorder. To allow for wide variations in concentration of the aerosol under test, a control circuit permits changing the time of exposure of the filter strip to the detector and a unit for diluting with air free of aerosols, a proportion of the aerosols contained in the airflow. There are means for absolute filtration of the air before arrival at the filter strip and a second detector associated with the absolute filtration. A threshold circuit sensitive to the measured radioactivity connected to the detector and to the control circuit can change the time of exposure of the filter strip at the first threshold of measured radioactivity. The diluting unit is actuated at a second threshold as is the means for absolute filtration at a third threshold. A second detector then measures the total radioactivity of the flow of air. (CANADA)

2461 ON THE USE OF SEMICONDUCTING DETECTORS OF NUCLEAR RADIATION IN GEOPHYSICAL INSTRUMENT CONSTRUCTION. Veretennikov, G. V. Geofiz. App., No. 35, 75-83 (1968). (In Russian).

Semiconducting diffusion detectors of nuclear radiation with the structure of n-p and n-i-p transitions are described. Starting from the properties of semiconductors and the mechanism of the n-p transition, the fundamental characteristics of semiconducting n-p counters can be regarded as a solid ionization chamber. One of the important characteristics of a semiconducting counter is its volt-amp curve. Low-noise counters are obtained if the shut-off current is reduced to a minimum. Some results of measurements of different kinds of radiation (α, β, and γ) in working with semiconducting detectors are discussed. (Geophys. Abstr.)

2462 ABSOLUTE CALIBRATION OF BETA–GAMMA SOURCES. Adam, G.; Katriel, J. (Nuclear Research Centre, Negev, Israel). Health Phys., 17: 731-2(Nov. 1969).

The conventional method of measuring the intensity of a beta-gamma emitter with a simple beta-gamma cascade requires the knowledge of the detectors efficiencies to the beta and gamma rays. The efficiencies depend on the geometry, energy spectrum and the constitution of the source (which determines the self-absorption). Modification of the conventional coincidence method which enables the determination of the sources activity without knowledge of these parameters is proposed. Two approaches are possible using two different detectors, or two identical detectors. (UK)

2463 ALPHA MONITOR FOR RAPID CONTAMINATION SCREENING OF HANDS AND SHOES. Splichal, W. F. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Appl. Technol., 8: 70-2(Jan. 1970).

Alpha contamination on the hands and shoes of personnel can be quickly detected with large-area air proportional counters modified to overcome sensitivity to microphonics and humidity. The monitor requires practically no servicing and is easily decontaminated. (auth)

2464 PLUTONIUM LUNG MONITOR USING A THIN NaI(Tl) CRYSTAL OF LARGE AREA. Ishihara, Tomio; Iinuma, Takeshi A.; Tanaka, Eiichi; Yashiro, Shigeo (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 17: 669-78(1969).

A Pu lung monitor has been constructed employing a combination of a large thin NaI(Tl) crystal and a photomultiplier of large photocathode. Size of the crystal is 8 in. diameter by 5 mm thickness to cover a large portion of the lungs, and the photomultiplier used (VMP/11/170) possesses a photocathode of 7 in. dia. that has been chosen for the best uniformity in photocathode sensitivity among five identical tubes. The whole detector was set in a shielding chamber of 20 cm thick iron plus 3 mm thick lead which is being used for the whole body monitor. Extraction of the optimum performance from the detector was attempted first by improving the energy resolution with insertion of light guide (made of Lucite) between the optical window of the crystal and the photocathode. An optimum thickness of the light guide was found to be 2 cm for the present detector. Then, background counts of the detector in the shielding chamber were analyzed and it was found that about 40% of the total background between 16 and 100 keV originated from γ-activities in the optical window and the glass envelope of the photomultiplier. Noise of the photomultiplier was dominant below 13 keV when no light guide was used, but interfered with the detection of 17 keV x-rays when light guide was inserted. Consequently, it was decided that no light guide be employed in the final form of the detector with a slight sacrifice in energy resolution. Counting efficiency for ^{239}Pu in the lungs was determined using a phantom that was made of Lucite plates. The counting efficiency was found to be 1.34×10^{-2} counts/sec/nCi of ^{239}Pu. The minimum detectable amount defined as 3 times the standard deviation of background counts is 6.2 nCi of ^{239}Pu for a counting time of 100 min. The background counts include those from degraded γ-rays of ^{137}Cs and K in a normal subject and correction was made on the counting efficiency due to absorption of x-ray photons by rib bones. The values obtained were rather tentative ones in view of uncertainties in the method of calibration, but they were well below the maximum permissible lung burden of ^{239}Pu. Some improvements for the future are discussed. (auth)

2465 PARAMETRIC PRE-AMPLIFIER CIRCUIT FOR CHARGED PARTICLE DETECTORS. Chase, R. L.; Radeka, V. (to United States Atomic Energy Commission). U. S. Patent 3,480,870. Nov. 25, 1969.

A parametric pre-amplifier circuit for charge signals from a solid-state charged particle detector is described. The system comprises a parametric oscillator and feedback control means for maintaining the oscillator in a stable oscillating condition in the presence and absence of input charge signals to the oscillator for producing an output that is a measure of the input charge signals. The circuit provides low noise amplification of charge signals with relatively high gain over a relatively broad band of frequencies. (AEC)

2466 RESPONSE OF 25 cm^3 Ge(Li) DETECTOR TO NEUTRONS: SHIELDING FACTORS. Rodda, J. L. Jr. (West Virginia Univ., Morgantown); Macklin, R. L.; Gibbons, J. H. Nucl. Instrum. Methods, 74: 224-8(1969).

The response of a large Ge(Li) detector to fast and slow neutrons was investigated. Characteristic gamma-ray pulse height distributions from a few hundred keV to over 1 MeV were obtained and prominent lines were identified. The effectiveness of an anticoincidence plastic scintillator shield, combined with a radiationless neutron absorber and a lead gamma absorber, was evaluated and found to be in good agreement with the calculated response. (auth)

2467 A NEW TECHNIQUE FOR THE DETERMINATION OF STOPPING POWERS OF GASES FOR VERY LOW ENERGY PROTONS. Warren, H. D. (Babcock and Wilcox Co., Lynchburg, Va.). Nucl. Instrum. Methods, 74: 181-4(1969).

A new method is proposed for measuring the stopping power of a gas for protons. A cylindrical proportional detector filled with

the subject gas can be used to determine the specific energy loss (−dE/dx) in a differential but continuous fashion from zero to about 0.5 MeV proton energies through the analysis of the thermal spectrum obtained from $^{3}He(n,p)^{3}H$ reactions inside the detector. The wall effect of the detector plays a prominent role in the new technique. Equations previously developed to account exactly for wall effects are applied to the thermal spectrum, and the result is a relationship which permits the determination of specific energy losses at very low energies by detecting protons and tritons at relatively high energies. This unique feature relieves some of the concern in conventional methods with interference from system noise, gamma radiation, and deterioration of energy resolution at very low energies. (auth)

2468 THE RESOLUTION OF A LARGE SODIUM IODIDE CRYSTAL USING ELECTRONS OF 25.2 MeV AND 40.8 MeV. Sashin, D.; Nadelhaft, I. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Instrum. Methods, 74: 191-6(1969).

The resolution of a large sodium iodide crystal (8 in. dia., 8 in. height) using electrons of energy 25.2 ± 0.5 MeV and 40.8 ± 0.8 MeV, was measured. Spark chambers made with very thin aluminum foil were used in conjunction with an analyzing magnet to measure the electron momentum. Scintillation counters and associated electronics triggered the system whenever an electron passed along an appropriately defined pathway. The magnet was calibrated by using a floating wire. The resolution (full width at half maximum of the crystal pulse height distribution) was 10.5% at both of the energies used. (auth)

2469 SYSTEMATIC INVESTIGATION OF THE PHOTORESPONSE OF SURFACE BARRIER SILICON pn JUNCTIONS. APPLICATION TO THE IMPROVEMENT OF THE FABRICATION PROCESS FOR AVALANCHE DETECTORS DESIGNED FOR SOFT X-RAY SPECTROMETRY. Peyre-Lavigne, A. (Univ., Toulouse); Dupre, J. C.; Blanc, D.; Petel, M.; Soudain, G. Nucl. Instrum. Methods, 74: 277-84(1969). (In French).

By irradiating the surface of a surface barrier detector with an x-ray beam (50 kV) or with a quasi-punctual luminous spot, the short-circuit current in a vacuum and in different gases (argon, oxygen, air) containing variable proportions of water vapor was measured. At the same time the relaxation time associated with the photoresponse was determined. These measurements made it possible to establish a series of criteria for fabrication of the surface barrier detectors to function in an avalanche regime. The comparison of the experiment values with those calculated by Cumerow's model and by that of the surface photopotential has furnished precise information on the structure of the p-n junction in view of a better knowledge of the avalanche mechanism. (auth)

2470 DIAMETER OF ETCHED FISSION FRAGMENT TRACKS IN SOLID STATE NUCLEAR TRACK DETECTORS AS A FUNCTION OF THE PARTICLE ENERGY. Hoeppner, U.; Konecny, E.; Fiedler, G. (Univ., Giessen, Ger.). Nucl. Instrum. Methods, 74: 285-90(1969).

Glass and several plastic materials have been irradiated orthogonally with respect to their surfaces by ^{235}U fission fragments of known mass and energy. A correlation between fragment energy and the diameters of the etched fragment tracks is given. For sufficiently long etching times the method is well capable of an energy resolution of about 3 to 5 MeV. A weak mass dependence of this effect is existing. To test the method a ^{252}Cf fission fragment energy distribution has been measured which is in good agreement with corresponding solid-state surface-barrier detector data. (auth)

2471 STATISTICS OF ELECTRON AVALANCHES IN THE PROPORTIONAL COUNTER. Byrne, J. (Univ. of Sussex, Brighton, Eng.). Nucl. Instrum. Methods, 74: 291-6(1969).

The statistical distribution of the number of electrons in the avalanche generated in a proportional counter by a single initial electron is analyzed by dividing the electrons into two groups differentiated by whether they have or have not sufficient energy to produce additional electrons by ionization. An approximate solution to the problem is obtained by application of the generating function technique to the resulting two-variable master equation. It is shown that the electron number is distributed according to a Polya law characterized by a parameter which may be determined from the conditions of electric field and pressure and the properties of the gas. The predictions of the theory are found to be in good agreement with the experimental results for methane. (auth)

2472 MONITOR CELL FOR ALPHA ACTIVITY IN LIQUID PROCESS STREAMS. Randolph, H. W. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Instrum. Methods, 74: 351-2(1969).

An in-line monitor cell for alpha activity that has good resistance to contamination is described. (auth)

2473 EFFICIENCY CALIBRATION OF Ge(Li) DETECTORS USING A RADIUM SOURCE. Wallace, G. (Victoria Univ., Wellington, New Zealand); Coote, G. E. Nucl. Instrum. Methods, 74: 353-4(1969).

The decay of radium and its daughters has been re-investigated for use in relative efficiency calibration of Ge(Li) detectors. (auth)

2474 RESPONSE OF BF_3 COUNTERS TO NEUTRONS IN MODERATE GAMMA FIELDS. Verghese, K.; Bohannon, J. R.; Kowalczuk, A. D. (North Carolina State Univ., Raleigh). Nucl. Instrum. Methods, 74: 355-7(1969).

It is found that discrimination against gamma rays while counting neutrons using a BF_3 tube, is not affected even at gamma exposure rates up to about 12 R/h. (auth)

2475 METHOD FOR DETERMINING THE OPTIMUM ANODE-CATHODE GEOMETRY OF IRREGULARLY SHAPED COUNTERS. Akutsu, J. (Inst. of Physical and Chemical Research, Yamato, Japan); Kanno, K. Nucl. Instrum. Methods, 74: 245-50(1969).

In order to obtain good plateau characteristics in an organic-vapor quenched GM counter tube with asymmetric form cathode, a graphical method for determining the optimum position of the anode inside the cathode is described. The method is based on the results of the analysis of relations between the plateau characteristics and the capacitance of the counter tube itself. The applicability of the method in relation to the plateau characteristics obtained in several counters having asymmetric-form cathode is examined. (auth)

2476 A CORRELATION METHOD FOR NEUTRON FLUX MEASUREMENT IN NUCLEAR REACTORS. Weiss, Harald (Atominstitut, Vienna). Atomkernenergie, 14: 375-80(Nov.-Dec. 1969).

Several types of ion chambers for neutron flux measurement in nuclear reactors cannot be constructed for gamma compensation, as for instance, in-core chambers and long ion chambers. This disadvantage may be overcome utilizing the Campbell technique (i.e., measurement of the a−c component of ion chamber current) which has excellent gamma discrimination compared with that of d−c channel. However, the operating range of a campbelling channel is very limited by the lowest signal to noise ratio which can be tolerated. This is especially true for small in-core chambers with mineral insulated cables, where the application of the Campbell technique has been very questionable or even impossible until now. A correlation method is described whereby an improvement of the signal-to-noise ratio of two to three decades is achieved. The method is based on the following principle: Two signals are obtained from the ion chamber; one from the center electrode as usual and an additional one from the outer electrode. The signals−after being separately amplified−are cross-correlated by means of a simple correlator. The cross-correlation function obtained for zero delay time, is a measure for the neutron flux and is independent of the channel noise. An a−c channel based on this principle is described which can also be used for a normal Campbell system. Measurements are discussed which were performed with this channel using a boron coated ion chamber and a fission chamber. Compared with a normal Campbell system an increase in operating range up to three decades was obtained. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 3953.

2477 (CEA-R-3823) THE n,γ DISCRIMINATION IN RECOIL-PROTON PROPORTIONAL COUNTERS. APPLICATION TO THE MEASUREMENT OF FAST NEUTRON SPECTRA. Jeandidier, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 72p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Paris Univ., France.

A description is given of a spectrometry chain working in the energy range of a few keV to 1 MeV, and designed for measurement of fast neutron spectra. It consists of detectors, recoil proton proportional counters built especially for this work by R. Comte (DEG/SER). A brief description is first given of the (n,p) collisions in the gas and the influence of γ radiation, and the method of discrimination is then presented. It is based on the difference in the rise-times of the pulses. In the experiments described the use of a bi-parametric system made it possible to employ the most simple discrimination device, based on the fact that the high frequency gamma pulse components are, at a given energy, weaker than those of the neutron pulses. Results are

given of measurements carried out on the Van de Graaff (monoenergetic neutrons for testing the linearity of the chain and the resolving power of the counters), and of those made in a subcritical system HUG at Cadarache. (auth)

2478 (INP-676) TRANSISTORIZED MODULAR SYSTEM FOR SLOW NEUTRON SPECTROMETRY. Zaleski, Tadeusz; Olejarczyk, Wiktor; Sokolowski, Janusz (Institute of Nuclear Physics, Krakow (Poland)). Feb. 1969. 9p. (In Polish). Dep. CFSTI (U. S. Sales Only).

A transistorized modular system using boron trifluoride proportional detectors for slow neutron spectrometry developed in the Neutron Laboratory at the Institute of Nuclear Physics, Krakow, is described. Several systems of this type are operating with the pulsed reactor at the Joint Institute of Nuclear Research in Dubna (SU) and at the Boris Kidric Institute of Nuclear Research (Yugoslavia). Construction details and technical data of individual modules are given. (auth)

2479 FAST NEUTRON SPECTROSCOPY BY PROTON RECOIL IN STILBENE. Broecker, B.; Fabian, H. U. (Univ., Kiel). Atomkernenergie, 14: 408-16(Nov.-Dec. 1969). (In German).

A method is given for the measurement of neutron spectra from 1 to 14 MeV with stilbene scintillation counters by recoil protons. The measured pulse height spectra are transformed into energy spectra, which are then corrected for double scattering of neutrons and wall escape of protons. From the corrected proton spectrum the neutron spectrum is derived by a numerical differentiation process. The formulae are programmed for a computer in ALGOL-code. The method is applied to an Am-Be and a 14 MeV spectrum. (auth)

2480 DESIGN OF A MAGNETIC SPECTROMETER FOR PHOTOELECTRON SPECTROSCOPY. Fadley, C. S.; Miner, C. E.; Hollander, J. M. (Univ. of California, Berkeley). Appl. Phys. Lett. 15: 223-5(Oct. 1, 1969).

Results are presented of a computer design study for an iron-free double-focusing magnetic spectrometer specifically intended for photoelectron spectroscopy. With single detector operation the proposed design is more efficient than any existing magnetic double-focusing spectrometer, and the focal-plane characteristics allow more than a 100-fold increase in data accumulation rate with a multichannel detector. This design also has very high physical accessibility near the source and detector areas and it is compatible with either normal or ultrahigh vacuum operation. (auth)

2481 TWO PARTICLE SPECTROMETER FOR THE (p,2p) REACTION. Andrews, P. T.; Butler, P.; Cohen, N.; James, A. N.; Lowe, B. G. (Univ. of Liverpool). Nucl. Instrum. Methods, 74: 300-8(1969).

An apparatus which has been used to study the (p,2p) reaction at 387 MeV is described. Two magnetic spectrometers analyzed the momenta of the two outgoing protons in the range 440 to 780 MeV/c and with a 10° angular range in the scattering plane. The resolution of the system was limited by multiple scattering in the acoustic spark chambers which were used to locate the particle tracks through the spectrometers. (auth)

2482 HIGH PRECISION GONIOMETER FOR CHARGED PARTICLE SPECTROSCOPY. Thompson, K. M.; Gruhn, C. R. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods, 74: 309-14(1969).

A high precision goniometer capable of positioning Ge(Li) charged particle detectors with a precision of ± 0.02° has been built. This device consists of a 4 ft radius, detector support which rotates outside of a central target vacuum chamber. The main features of the system are described and a summary of the tests to verify its operational capabilities is presented. A description is also given of the installation of the unit on the beam line, illustrating the precautions which were taken to ensure alignment. The performance of this apparatus in studying Ni(p,p') reactions at 40 MeV is discussed. (auth)

2483 NEUTRON SPECTROSCOPY WITH A ^{3}He PROPORTIONAL COUNTER. Fuse, T.; Miura, T.; Yamaji, A.; Yoshimura, T. (Ship Research Inst., Tokai, Japan). Nucl. Instrum. Methods, 74: 322-4(1969).

Neutron spectroscopy with a ^{3}He filled proportional counter is described. The response functions were calculated. The unfolding was made in such a way that a single Gaussian-like peak would appear in the output for a monoenergetic source. The result of the neutron measurement in a swimming-pool type reactor was satisfactory for 43 neutron energy groups. (auth)

2484 PULSE-SHAPE DISCRIMINATION IN A COINCIDENCE SPECTROMETER USING A GERMANIUM DETECTOR. Forest, H.; Huguet, M.; Ythier, C. (Faculte des Sciences, Nice). Nucl. Instrum. Methods, 74: 325-8(1969). (In French).

A simple and accurate pulse shape discrimination method is described for coincidence spectrometers using Ge(Li) detectors. Gamma ray pulses degraded by electron interaction in Ge(Li) detector's dead layers are rejected within 40% by delaying the Ge(Li) crossover signals. Spectra given by a Ge(Li)-NaI(Tl) three-crystal pair spectrometer with and without rejection are shown. Results are compared with elaborated and much more expensive methods. (auth)

2485 AN ALL SODIUM IODIDE ANTICOINCIDENCE SHIELDED MULTIDIMENSIONAL GAMMA-RAY SPECTROMETER FOR LOW-ACTIVITY SAMPLES. Wogman, N. A.; Perkins, R. W.; Kaye, J. H. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Nucl. Instrum. Methods, 74: 197-212 (1969).

A multidimensional gamma-ray spectrometer detector system has been developed which employs two 23 cm dia by 20 cm thick NaI(Tl) crystals as its principal detectors. Each detector is viewed through 7.6 cm thick pure NaI light pipes by photomultiplier tubes and is surrounded by 38 cm dia by 28 cm thick NaI(Tl) anticoincidence shields. Each principal detector, along with its light pipe and anticoincidence annulus, is hermetically sealed in a single container. The detector system is coupled to a 4096 word computer memory spectrometer and uses the gamma-ray decay characteristics of each radionuclide for its identification and measurement. This is accomplished by viewing the sample with the two NaI(Tl) detectors operated in coincidence and canceling those events not totally absorbed in the principal detectors by the anticoincidence annulus. Coincidence counts are stored in the energy-energy plane of the memory according to their photon energies, while single gamma rays which interact with either crystal are stored in a normal manner on the X or Y axis. The background response of this detector system has been measured at ground level and at 110 m below ground level where the cosmic-ray contribution is minimized. The two principal sodium iodide crystals have resolutions of 8.7% and 9.2% fwhm, respectively, at the ^{137}Cs 0.662 MeV photopeak. The absolute efficiency for counting the 0.662 MeV ^{137}Cs gamma ray is about 60%, while the coincidence counting efficiency for the ^{60}Co gamma ray is about 14%. This detector system provides the most sensitive means available for the direct measurement of many radionuclides in environmental or extraterrestrial samples. The background contribution has been resolved to show the fraction caused by natural radioactivity in the detector system, that from the surrounding shielding, and that from cosmic radiation. The backscatter, Compton response, and efficiency parameters of the detector system are discussed and compared with other detector systems of somewhat similar design. The application of this instrument to several environmental studies is discussed. (auth)

2486 SOLID-STATE DETECTOR SPECTROMETERS FOR DETERMINATION OF MULTIPLE ORDERS OF NUCLEAR TRANSITIONS. Gizon, J. (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Instrum. Methods, 74: 213-18(1969). (In French).

A description of an apparatus for the measurement of internal conversion coefficients is presented. The determination of multipole orders of nuclear transitions by simultaneous countings of electron spectrum with silicon detector and gamma spectrum with germanium detector is examined. Application to the decays of ^{171}Hf and ^{171}Lu is included. (auth)

2487 SLIT SCATTERING EFFECTS WITH MEDIUM ENERGY ALPHA PARTICLES AND PROTONS. Resmini, F. G.; Bacher, A. D.; Clark, D. J.; McClatchie, E. A.; De Swiniarski, R. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 74: 261-7 (1969).

The slit scattering effect has been measured for medium energy protons and alpha particles on aluminum, brass and tantalum slits. A successful comparison with the theoretical treatment of Courant has enabled us to predict the slit scattering effect for our experimental conditions lending credence to the application of the Courant theory to other experimental conditions. (auth)

2488 A NEW TYPE OF NEUTRON SPECTROMETER IN THE ENERGY RANGE 1 TO 100 keV. Maroni, C.; Russo, F.; Verondini, E. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nucl. Instrum. Methods, 74: 256-60 (1969).

A neutron spectrometer using the ^{6}Li(n,α)^{3}H reaction is described, in which the energy difference between the outgoing particles is recorded. A resolution of about 40 keV on the energy difference allows to obtain resolution as low as 1 keV on the neutron energies. (auth)

2489 CALCULATION OF PILE-UP SPECTRA. Waibel, E. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods, 74: 236-44(1969). (In German).

Pulseheight spectra caused by pile-up effects have been calculated considering the influence of the pulse shapes of amplifiers and the dependence of analog-digital conversion on pulse duration. The results are compared with experimental pile-up spectra. A program has been made which enables the easy calculation and elimination of pile-up spectra in nuclear spectroscopy. (auth)

2490 IDENTIFICATION OF UNKNOWN PEAKS IN A FISSION PRODUCT GAMMA SPECTRUM. Dreisvogt, Herbert (Technische Hochschule, Aachen). Atompraxis, 15: 340-2(Sept.-Oct. 1969). (In German).

Gamma spectrometry using semiconductor detectors renders essentially better resolution of complex spectra than attainable with conventional scintillation counters. In order to identify semiconductor spectra of thorium–uranium fission product mixtures, a program capable of calculating line spectra of any irradiation condition was compiled. The programmed line spectrum is composed with a spectrum measured to decipher the specific peaks. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 2515 and 3490.

2491 (N-69-34548) COSMIC RAY AND HIGH ENERGY PHYSICS STUDIES IN SPACE. Kaufman, L. (Bellcomm, Inc., Washington, D. C.). Apr. 1, 1969. Contract NASw-417. 49p. (NASA-CR-104069; TR-69-103-1). CFSTI.

The design of a space facility that can perform relevant measurements on the primary cosmic ray flux in the energy range from a few GeV to 10^8 GeV is presented. It is shown that a small increment in the instrumentation of a cosmic ray space station, together with the versatility provided by the presence of men rearranging and servicing the hardware, could give an experimental facility that would also provide vital information in the field of high energy physics. Hardware appropriate for space use is described, and various configurations with a large superconducting magnet as the central element are shown. The magnet's capabilities are compared to those of ionization calorimeters. The implementation of this program is intimately tied to the techniques and needs of accelerator-directed high energy physics, and the involvement of the high energy physics community in this project is presented as a necessary ingredient for its worthiness. (auth)

2492 (RHEL/R-183) PROCEEDINGS OF A SEMINAR ON FUTURE DEVELOPMENT OF AUTOMATIC BUBBLE CHAMBER FILM MEASUREMENT, 13th OCTOBER 1968. Butterworth, I.; Fisher, C. M. (eds.) (Rutherford High Energy Lab., Chilton (England)). June 1969. 53p. (CONF-681068). Dep. CFSTI (U. S. Sales Only). UK 10s.

The following papers are presented, with discussions: Present status of well established measuring devices–I. Butterworth (RHEL); PEPR systems–C. B. Brooks; J. F. Harris (Oxford Univ.); "Sweepnik"–O. R. Frisch (Cambridge Univ.); "Sweepnik" performance to date–G. S. B. Street (Cambridge Univ.); What is right and what is wrong with HPD–J. W. Burren; "Polly" systems–C. Robinson; Bubble images in the new chambers–W. T. Welford (Imperial Coll., London); Work done by LBCG Group at CERN–F. W. Bullock (University Coll., London); Precision of optical constants of 12 ft. Argonne chamber (W. T. Welford, Imperial Coll., London); Scan-measure system for Gargamelle–M. J. Esten (University Coll., London); and Future work on PEPR–P. G. Davey (Oxford Univ.). (UK)

2493 (UCRL-18846) WIRE SPARK CHAMBERS IN SPECTROMETER EXPERIMENTS. Perez-Mendez, Victor; Sperinde, Johnie M.; Stetz, Albert W. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 15, 1969. Contract W-7405-eng-48. 8p. (CONF-690433-1). Dep. CFSTI.

From International Conference on Filmless Spark and Streamer Chambers, Dubna, USSR.

Wire spark chambers with magnetostrictive delay line readout are described. The design and electrical characteristics of these chambers and the use of on-line small computers are discussed. It is pointed out that experimental situations where the wire spark chambers are found most useful are those in which there is a possibility of measuring the vector momentum very precisely, and its mass by Cherenkov counters, allowing a selection of the desired reaction from a large number of competing events. (J.F.P.)

2494 PERFORMANCE OF A RAPID CYCLING HYDROGEN BUBBLE CHAMBER. Barney, H.; Rogers, A.; St. Lorant, S. J. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 74: 345-8 (1969).

A small hydrogen bubble chamber consisting of a convoluted bellows and driven by a loudspeaker-like coil expansion system was developed and tested to cycling rates of 90 Hz. (auth)

2495 DETECTION OF HIGH ENERGY PARTICLES USING TRANSITIONAL RADIATION. Alikhanyan, A. I.; Ispiryan, K. A.; Oganesyan, A. G. Yadern. Fiz.; 10: 549-57(Sep 1969). (In Russian).

The features of high-energy particle transitional radiation in the optical frequency region emitted under small angles are investigated. Possible use of the sharp energy dependence of the radiation to construct a detector which identifies high energy particles is discussed. A concrete construction of such a detector is presented. (auth)

Radiation Dosimeters

Refer also to abstracts 2455, 2519, and 2677.

2496 (CLOR-75/D) THERMOLUMINESCENCE READER FOR LOW AND HIGH TEMPERATURE PHOSPHORS. Glowacki, Stanislaw W. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1969. 22p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The thermoluminescence reader developed in Central Laboratory for Radiological Protection is described. The reader can be used for low as well as for high temperature phosphors. The instrument makes possible the analog measurement of the glow curve, or the digital measurement of the total amount of light. The maximum sensitivity for CaF_2 phosphor is 0.5 mR of exposure dose. (auth)

2497 (SWRHL-58-r) ENVIRONMENTAL MONITORING WITH THERMOLUMINESCENT DOSIMETERS. AN EVALUATION OF THE SYSTEM AND A COMPARISON TO PHOTOGRAPHIC METHODS. Fitzsimmons, Chas. K.; Horn, William H. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Oct 1969. 25p. Dep. CFSTI.

In August 1965, the Southwestern Radiological Health Laboratory put into operation a thermoluminescent dosimeter (TLD) system for monitoring gamma radiation exposure in the environment surrounding the Nevada Test Site. A description of the equipment and calibration technique is given. Precision of TLD results at the 95% confidence level has been found to be ±3.5%. Accuracy is on the order of ±5%. Actual field data ranging from background levels to about 1 R show TLD's to be more satisfactory than film badges for the particular applications described. (auth)

2498 LiF-THERMOLUMINESCENCE BY USE OF PARTIALLY IRRADIATED SINGLE CRYSTALS. Schmidt-Burbach, Gerhard M. (Gesellschaft fuer Strahlenforschung, Frankfurt am Main). Atompraxis, 15: 324-6(Sept.-Oct. 1969). (In German).

LiF is often used for thermoluminescence dosimetry—especially in research and medicine. To use this method one must know the relation between the integrated light-output and the absorbed dose when the irradiated crystal is heated up. This calibration (the response) is always performed by using rays, the range of which is large compared to the dimensions of a single-crystal. Together with the determination of the dose distribution in the neighborhood of a β-active particle in tissue, the response of a partially irradiated LiF-single-crystal is measured. An identical result was found in the case of x-ray penetration of a crystal as well as by total absorption of the energy in a partial volume of the crystal. (auth)

2499 COMPLETE SYSTEM FOR MEASURING GAMMA AND X-RAY INTEGRATED DOSES. van Wallendael, S. (Manufacture Belge de Lampes et de Materiel Electronique S.A., Brussels). Kerntechnik, 11: 592(Sept.-Oct. 1969).

The principles of thermoluminescence dosimetry are briefly discussed, and a method for total dose measurement using calcium fluoride is described. This method involves transferring the charge carriers trapped in the high-temperature traps (which are undisturbed at normal readout temperatures) to lower traps by ultraviolet irradiation, and then reading the total dose at normal readout temperatures. (W.H.K.)

2500 A HEAT LOSS COMPENSATED CALORIMETER AND RELATED THEOREMS. Domen, Steve R. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 73C: 17-20(Jan.-June 1969).

A new calorimetric design and measuring technique are proposed for reducing uncertainties caused by temperature gradients. A theoretical analysis reveals a mathematical theorem concerning heat transfer and its electrical analog. The instrument is intended for the measurement of the absorbed dose deposited in materials by means of ionizing radiation. (auth)

2501 VERSATILE CONTROLLER FOR THERMOLUMINESCENCE READ-OUT SYSTEMS. Gall, A.; Mason, E. W. (Radiological Protection Service, Scottish Centre, Glasgow). Phys. Med. Biol., 14: 661-4(Oct. 1969).

The design and operation of a temperature controller for use with a thermoluminescent dosimetry system is described. The controller enables any phosphor heating element temperature up to 450°C to be selected to within ±1°C and held to ±0.1°C. Facilities are available for artificial cooling. The light output from the phosphor is detected by a photomultiplier in the usual way. (UK)

2502 CLEAR PERSPEX H.X. AS A REFERENCE DOSEMETER FOR ELECTRON AND GAMMA RADIATION. Berry, R. J. (Churchill Hospital, Oxford); Marshall, C. H. Phys. Med. Biol., 14: 585-96(Oct. 1969).

Clear Perspex, made to a standard specification of the UK Panel on Gamma and Electron Irradiation, and known as Perspex HX, was assessed for use as a reference dosemeter for megarad doses of gamma and electron radiation by a group of laboratories in co-operation. The radiation-induced increase in optical density of the material was used as a measure of dose. Recommendations are made for the choice of wavelength for measurement. Calibration data for doses up to 5 megarads are included. Studies have been made on the reproducibility as a dosemeter, on the response of different batches of the material to the same dose, and on the post-irradiation fading of the induced optical density. Recommendations for handling the material to achieve full accuracy and reliability are made. (auth) (UK)

2503 A FERROUS SULPHATE DOSEMETER INDEPENDENT OF PHOTON ENERGY IN THE RANGE FROM 25 keV UP TO 50 MeV. Frankenberg, Dieter (Gesellschaft fuer Strahlenforschung mbH, Frankfurt am Main). Phys. Med. Biol., 14: 597-605(Oct. 1969).

A modified form of a ferrous sulphate dosemeter is described, which retains the accepted advantages of the Fricke dosemeter and possesses the following additional properties: (a) it determines the dose in water; (b) the response is independent (to within ±1.5%) of effective photon energy over the range 24 keV to 50 MeV and, therefore, independent of the shape of x-ray spectrum; and (c) the low concentration of sulphuric acid reduces the possibility of introducing impurities from the source. (auth) (UK)

2504 EFFECT OF THE WALL ON THE FRICKE DOSEMETER. Burlin, T. E.; Chan, F. K. (Regent Polytechnic, London). Int. J. Appl. Radiat. Isotop., 20: 767-75(Nov. 1969).

The influence of the wall on the response of the Fricke dosemeter is discussed and a survey of experimental work on this effect is made. A recent version of cavity theory is applied to this effect and the results of calculations covering a range of irradiation vessel radii from 0.1 to 5.0 cm and a range of photon energies from 0.20 to 3.0 MeV are presented. Experimental data obtained on a ^{60}Co irradiation unit are compared with these calculations and the agreement is within the limits of experimental uncertainty. (auth) (UK)

2505 RADIOLOGIC PROTECTION OF THE POPULATION IN CASE OF NUCLEAR CATASTROPHE. Tech. Sci. Munic., 64: 130(Apr. 1969). (In French).

The best solution to the analysis of the amount of radiation received by the population after a nuclear catastrophe is individual dosimetry, but this is impractical. A new method is proposed based on the incorporation of bricks or plates into buildings that act as dosimeters. They have the appearance and resistance of ceramic but are composed of 96% thermoluminescent aggregates and 4% binder; emission is proportional to the intensity of radiation received. They can be incorporated easily into masonry and carry identification numbers. The plates are designed for insertion into walls by concrete, for example, and likewise carry identification numbers. The method requires a laboratory that can be installed in a small truck. The sampling procedure is outlined. Various advantages of the bricks from a practical viewpoint, especially the reaction of the population to them, are noted. (BBB)

2506 INVESTIGATIONS ON THE DOSIMETRY OF SMALL RADIOACTIVE PARTICLES. Schmidt-Burbach, Gerhard M. (Gesellschaft fuer Strahlenforschung, Frankfurt am Main). Atompraxis, 15: 345-9(Sept.-Oct. 1969). (In German).

Small radioactive particles were made, and were homogeneously surrounded by 0.6 μm to 885 μm thick tissue-equivalent absorbing layers. The distribution of the absorbed energy was measured by LiF-thermoluminescence. From the distribution of the absorbed energy the distribution of the absorbed dose was found, and was compared with the theories given by Loevinger and Spencer. (auth)

Radiometric Instruments

Refer also to abstract 2302.

2507 ON THE CHOICE OF GAMMA-RADIATION FILTERS FOR SONDES OF THE GAMMA–GAMMA DENSITY METHOD. Artsybashev, V. A.; Ivanyukovich, G. A. Geofiz. App., No. 35, 55-61(1968). (In Russian).

Use of single-crystals of NaI(Tl) scintillation detectors with aluminum filters for recording the integral counting rate is not permissible in gamma-gamma density logging because the error in density determination is ±5 percent when the effective atomic number (Z_{eff}) of the rocks varies by ±2. It is recommended that a sonde with iron filter 3 to 5 mm thick be used as the main variant of the integrating scintillation apparatus for density logging. Such a sonde is suitable for measuring the density of most rocks and ores, and the error is within ±1 percent when Z_{eff} varies by ±2. To study the density of ores, it is desirable to provide an auxiliary lead filter 1 to 3 mm thick, which eliminates the effect of the composition of rocks in the range Z_{eff} = 7 to 20 and reduces the error of density measurement to ±1 percent when Z_{eff} varies by ±2 in the Z_{eff} range less than 20. When the lead filter is used, the strength of the gamma-ray source must be increased 3 to 4 times. (Geophys. Abstr.)

2508 RADIOACTIVE SENSOR FOR MEASURING LIQUID LEVELS. Elliott, David D.; Mozer, Forrest S. (to Secretary of the Air Force). U. S. Patent 3,473,021. Oct. 14, 1969. Filed June 27, 1966.

An apparatus which utilizes nuclear radiation for measuring liquid levels in the fuel tanks of gyrating aircraft is described. The apparatus comprises a plurality of elongated radiation sources positioned within the interior portion of a fuel tank together with an equal number of detection devices positioned outside the tank and opposite to the radiation sources. (auth)

2509 ADJUSTABLE LEAD SHIELD FOR SCINTILLATION LOGGING STATIONS. Kirpishchikov, S. P.; Rasputin, V. A. Geofiz. App., No. 36, 154-6(1968). (In Russian).

The construction of an adjustable lead shield designed for periodic shielding of the single crystal of NaI(Tl) installed in a scintillation logging station is described. Data obtained in work with this station are used both for lithological subdivision of sections and for quantitative determination of radioactive elements. (Geophys. Abstr.)

2510 OPTIMAL CONSTRUCTION OF APPARATUS FOR MEASURING THE DENSITY OF ROCK SAMPLES BY THE $\gamma-\gamma$ METHOD. Artsybashev, V. A. Geofiz. App., No. 36, 160-3 (1968). (In Russian).

This paper gives the fundamental parameters of apparatus for measuring the density of samples of rocks and ores by the method of penetration by beams of gamma radiation. Of two versions of the apparatus, preference is given to a scheme with an immovable block source of gamma–radiation. It is recommended that density standards in the form of a set of steel plates be used to regulate the apparatus. (Geophys. Abstr.)

2511 STABILITY REQUIREMENTS OF THE ELEMENTS OF THE ELECTRONIC SCHEME OF BOREHOLE INSTRUMENTS. Gubin, Yu. A.; Yasemenov, E. V. Geofiz. App., No. 36, 146-53 (1968). (In Russian).

The stability requirements of the amplification coefficient of the amplifier, threshold of discrimination, and rectifier of the current supply to the photomultiplier in radioactivity logging apparatus operating in the plateau regime are discussed. These requirements are determined by the ratio of the amplitude of the minimum detectable signal to the maximum noise of the photomultiplier–detectors, and are independent of the type of photomultiplier, its parameters, and the extent of the plateau in volts. The absolute extent of the plateau in volts is determined by the signal-to-noise ratio and curvature of the anode characteristic of the photomultiplier. (Geophys. Abstr.)

2512 MEASURING MOISTURE BY NEUTRON MODERATION AND SCATTERING. Toelgyessy, Juraj; Dillinger, Pavel (Technical Coll., Bratislava). Chem. Listy, 63: 737-76(July 1969). (In Czech).

A brief introduction is given to various methods of determining moisture with stress on nuclear methods because of the possibility of continuous determination of moisture. Thermalization and diffusion of the thermalized neutrons are discussed with a tabulation of data on elastic and inelastic cross sections, and slowing-down lengths for the usual elements encountered in soil. The theoretical bases of measuring moisture by neutron slowing down and diffusion are presented along with the characteristics of various (alpha,n) and (gamma,n) neutron sources. Maximum and average neutron energies, neutron fluxes and gamma readings are given for Po–Be, (Pu-239)–Be, (Am-241)–Be, (Sb-124)–Be and other sources. Various types of neutron probe detectors are discussed. Methods of calibration, taking of the data, and statistical treatment of the results are presented. Neutron moisture meters from different countries (USA, USSR, Germany, England, etc.) are described. 130 references. (TTT)

Miscellaneous Instruments and Components

Refer also to abstracts 2305, 2411, 2746, 3028, 3991, and 4162.

2513 (ANL–7584) NOTE ON ERROR ESTIMATION WHEN A CALIBRATION CURVE IS USED. Jaffey, Arthur H.; Lerner, Jerome L. (Argonne National Lab., Ill.). July 1969. Contract W-31-109-eng-38. 24p. Dep. CFSTI.

This note examines error estimation associated with a particular use of a calibration curve. The essential features appear in the case of a measuring device whose detection efficiency Y varies with time x. Measurements with several standard samples are used to construct a calibration curve of efficiency versus time, $Y = f(x)$, and this curve is used to correct all measurements to a standard efficiency. The measured values for one of the standards are also so corrected, and the squared error in the average is estimated as a sum of squared deviations from the average, divided by ν, the number of degrees of freedom. With n denoting the number of data points with the specified standard, ν should be less than n, as in the usual least-squares analysis, because of the correlation introduced by use of the same quantities in estimating $Y = f(x)$. It is conjectured that ν should be taken as $n - 1 - F\theta$, where F is the number of fitted parameters used in $Y = f(x)$ in addition to the location parameter, and $\theta = n/p$, with p the total number of points used in estimating $Y = f(x)$. The conjecture is not proven, but agrees closely with results evaluated for some sample calibration curves. These results are determined analytically for a straight line $Y = f(x)$, and through Monte Carlo sampling for a 4th- and an 8th-order polynomial curve. The appendix includes some discussion on the choice of an adequate pseudo-random generator of Gaussian deviates. (auth)

2514 (CERN–69-26) PULSE SHAPERS FOR STANDARDIZING PHOTOMULTIPLIER SIGNALS AND FOR OTHER APPLICATIONS. Verweij, H.; Vismara, G. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 2, 1969. 55p. Dep. CFSTI (U. S. Sales Only).

Two general-purpose pulse shapers are described. They convert signals from photomultipliers and other sources to pulses of logic amplitude (–800 mV) and adjustable width. The input circuits of both units are identical, also their output circuits, but the output pulse-width is defined differently. In one case it is determined by a coaxial cable (type N 2620), and in the other by an inductance (type N 2618). The input threshold is fixed and equal to –50 mV or –350 mV. An output fan-out delivers two dual logic outputs and one dual complementary logic output. The minimum output pulse-width is ~3.2 nsec. The maximum frequency of operation is at least 100 MHz. The units are part of the CERN-NIM compatible nucleonic instrument range. (auth)

2515 (DNPL/P–16) USE OF INTERACTIVE COMPUTER GRAPHICS IN HIGH ENERGY PHYSICS. Chau, A. Y.; Davies, B. W.; Richmond, P. M.; Zacharov, B. (Daresbury Nuclear Physics Lab. (England)). Aug. 1969. 10p. (CONF-690706–2). Dep. CFSTI (U. S. Sales Only).

From Conference on Computational Physics, Culham, England.

It is pointed out that many computing problems in high energy physics can profitably be solved by iterative procedures. Illustrations of the use of computer graphics in this field are given by reference to studies in progress at DNPL. Applications include the design of magnet systems for beam optics configurations, with particular regard to magnet spectrometers; the display of ambiguous events in spark chamber experiments; the creation, examination, and manipulation of statistical aggregates arising from experimental data; aid for varying the parameters of a mathematical function superimposed on a display of experimental data. Comments are made on user experience and an indication is given of the reduction in overall time which has been achieved by the introduction of interactive graphics. (UK)

2516 (LA–4234) CALIBRATION OF A TWO-STAGE AIR SAMPLER. Ettinger, Harry J.; Royer, George W. (Los Alamos Scientific Lab., N. Mex.). Aug 1969. Contract W-7405-eng-36. 7p. Dep. CFSTI.

A two-stage sampler consisting of a nylon cyclone, followed by a glass fiber filter was calibrated using monodisperse test aerosols. Cyclone efficiency, as a function of sampling flow rate, and aerosol aerodynamic diameter were determined. At a flow rate of 1.7 liters/min, this sampler provides a good estimate of respirable dust concentration. (auth)

2517 (RN-DR–124) PNEUMATIC INSTRUMENTATION LINES AND THEIR USE IN MEASURING ROCKET NOZZLE PRESSURE. NERVA PROGRAM. Samuelson, R. D. (Aerojet-General Corp., Sacramento, Calif.). July 1967. Contract SNP-1. 131p. Dep. CFSTI.

Pressure measurements are required to determine nuclear rocket engine performance and to satisfy control system requirements. However, when the available pressure transducers are subject to radiation damage, it is necessary to place them behind radiation shields and couple them to the engine with pneumatic tubing. As a result, the frequency response of the measurement system is degraded. It is attempted to describe the operational characteristics of pneumatic instrumentation lines and to discuss the infinite-line technique that was used to minimize the detrimental coupling effects of pneumatic tubing during the NERVA NRX/EST test series. (W.H.K.)

2518 (UCRL–50688) FALLOUT DISPLAY SYSTEM (FODS) OPERATOR'S MANUAL. Peschel, Donald J. (California Univ., Livermore. Lawrence Radiation Lab.). May 22, 1969. 30p. Dep. CFSTI.

The Fallout Display System (FODS) is a digital computer-driven device which generates and displays radioactive fallout prediction patterns for nuclear detonations. A cathode ray tube forms the graphic pattern as an overlay on a selectable, projected map. The Army Fallout Prediction pattern and a gradient pattern developed from a physical model are available. The system is contained within a console possessing the 30 in. square display screen and operator control panels. An operator from the console inputs data for the detonation and controls the type and development of the display pattern. Each input parameter and display control is described along with the operating sequence to run a problem. Error conditions sensed and displayed on the console for the operator are explained. A sample problem with photographs of the patterns is presented. An appendix describes how to initially load the computer program and prepare the system for operation. (auth)

2519 (UCRL–71766(Rev.1)) LINEAR SEVEN-DECADE CURRENT/VOLTAGE-TO-FREQUENCY CONVERTER. Shapiro, Edward G. (California Univ., Livermore. Lawrence Radiation Lab.). June 1969. 24p. (CONF-691017–3). Dep. CFSTI.

From 16th Nuclear Science Symposium, San Francisco, Calif.

A current-to-frequency converter was developed for low level current measurements of wide dynamic range. It measures currents from 5×10^{-13} to 6×10^{-5} amperes without range switching and by the use of state-of-the-art circuit components. It has a corresponding linear seven-decade transfer characteristic of 10^{-11} amperes per Hertz with a maximum output frequency of greater than 5×10^{6} Hertz. The converter was designed to monitor photomultiplier tube current in an automated thermoluminescent dosimetry (TLD) system. (auth)

2520 (UCRL–Trans–10381) PROCESSING BY COMPUTER OF DATA SUPPLIED BY A QUADRUPOLE MASS SPECTROMETER. Ronteix, P. Translated by Ralph L. McElroy for Univ. of California Lawrence Radiation Lab., Livermore, from Chim. Anal. (Paris), 51: 290-5(1969). 12p. Dep. CFSTI.

Because of the speed of scanning and the linear nature of the spectra, quadrupole mass spectrometers simplify the establishment of a simple relation between the spectrometer and the adjustments of the operational controls on the computer. The possibilities of a quadrupole spectrometer–computer combination are described; and it is shown how the computer and the operator, working together, can perform operations corresponding to those carried out by a larger computer with more complex programming. (auth)

2521 POSITION SENSOR. Lemercier, Daniele; Lemercier, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,165,810. Oct. 1, 1969. Priority date Aug. 10, 1966, France.

A capacitance-type position sensor which is insensitive to neutron bombardment for use in swimming pool reactors is described. (W.H.K.)

2522 RESPONSE TIME OF NiCr–Ni MINERAL-INSULATED THERMOCOUPLE ASSEMBLIES IN A HELIUM ATMOSPHERE. Diehl, W. (Metall-Laboratorium der Degussa, Hanau, Ger.). Atompraxis, 15: 326-30(Sept.-Oct. 1969). (In German).

Investigations of the time response characteristics of NiCr–Ni mineral-insulated thermocouple assemblies in gaseous helium under nuclear reactor conditions (at high velocities and high pressures) are described. The values of the time constant τ to be obtained under these conditions depend strongly on the type of the mineral-insulated thermocouple assemblies. The best results (τ = 0.17 sec) were obtained with mineral insulated thermocouple assemblies of 1.5 mm outer diameter, with the hot junction welded in the sheath. (auth)

2523 ATTEMPT TO USE THE LSU 5K ANALYZER TO DETERMINE U(Ra), Th, AND K IN BOREHOLES. Novikov, G. F.; Sinitsyn, A. Ya. Geofiz. App., No. 35, 158-64(1968). (In Russian).

With minor alterations of the pulse analyzer, the LSU-5K laboratory apparatus can be used to determine U(Ra), Th, and K in boreholes. The whole logging setup, consisting of the well instrument, lead-in block, LSU-5K pulse analyzer, and winch with cable, is installed in a GAZ-69 machine. Error in determining the U(Ra), Th, and K contents in the case where the channel is loaded with a total count up to 5,000 imp per sec is in agreement with computed data obtained on the basis of the statistical regularities of the decay and recording of the radiation. (Geophys. Abstr.)

2524 TIME-AMPLITUDE CONVERTER. Manca, J. (Inst. of Electrical Engineering, Bratislava). Jad. Energ., 15: 308-10(1969). (In Czech).

A transistorized time-to-amplitude converter is described, which has been developed for the observation of the decay modes of mesons at a high energy accelerator. The resolution of the converter is better than 1 ns, the measuring time interval is from 40 to 160 ns and the integral linearity is within ±0.5%. (auth)

2525 JANUS: A REALTIME TIMESHARING COMPUTER SYSTEM FOR USE IN NUCLEAR PHYSICS EXPERIMENTS. Kopf, John Oscar. East Lansing, Mich., Michigan State Univ., 1968. 167p.

Thesis.

A computer program called JANUS was developed for use on a Scientific Data Systems Sigma Seven computer. JANUS is a computer operating system, designed to permit many different users to share the resources of the computer, such that each user is apparently in sole control of the machine. These resources include the time available for operation, the program and data storage available, and communication links with the world external to the computer. A comparison of the means and mechanisms of resource management provided by various computer operating systems, including JANUS, is presented. Descriptions of inadequacies, both in hardware and in operating systems, are given, with suggestions on possible improvements in future implementations. In those cases where it has been possible to measure various parameters under JANUS operation, the measurement and a comment on its significance is provided. Reference manuals for JANUS and various control monitor tasks are appended, as well as thoughts on the possible implementation of other desirable processes. A novel method was developed to handle realtime processes. The computer may be used to simultaneously control devices, acquire data, and perform analysis and computation. Any process may be started or stopped at random, irrespective of the other usage of the machine. The flexibility introduced into the use of the computer, compared with conventional realtime systems, is impressive, since, if necessary, all of the resources of the computer may be directed toward any goal, using a single operating system, without the overhead normally associated with such systems. This is accomplished by providing within the resident monitor only those primitive functions dealing with resources common to all usage. Higher level functions, such as Input/Output, are provided by independent timeshared tasks. These tasks, with the features normally associated with conventional monitors, provide those functions necessary and sufficient to the operation of a specific set of problems. (Diss. Abstr.)

2526 ANALYSIS OF COMPOSITE NEUTRON MONOCHROMATOR SYSTEMS CONSISTING OF CURVED CRYSTALLINE LAMELLAS. Rustichelli, F. (Institut Max von Laue, Grenoble, France. CCR-EURATOM, Ispra, Italy). Nucl. Instrum. Methods, 74: 219-23(1969).

Composite neutron monochromator systems consisting of curved crystalline lamellas were studied. The conditions were derived under which such systems can transform a parallel polychromatic neutron beam into a diffracted beam in which the neutron momentum is dependent upon the secondary ray direction. Such a transformation was proposed recently by Maier-Leibnitz, who considered a system of monocrystalline plane lamellas having a small mosaic spread η and stressed its advantages in neutron physics. One advantage is, for instance, the elimination of superposition of the several order (hkl) reflexes in the Laue method. The present paper shows that the original system of plane lamellas is a particular case (corresponding to the curvature radius R = ∞) of infinitely many possible systems of curved lamellas. All these systems are equivalent, i.e., realize the same transformation of neutron beams, but they differ because the curvature radius of the lamellas depends upon their orientation with respect to the incident beam. The curvature of perfect crystals substitutes for the mosaic spread of the plane lamellas in the elimination of primary extinction. These results suggest alternative approaches to the experimental realization of the neutron beam transformation. (auth)

2527 TIME-TO-DIGITAL CONVERTER. Pozar, F. (Frieseke and Hoepfner, Erlangen, Ger.). Nucl. Instrum. Methods, 74: 315-21(1969).

A new instrument for time control and adjustment to be used in computer controlled multicounter experiments is presented. The proposed time-to-digital converter is a parallel unit to the ADC. (auth)

2528 IMPROVED TUNNEL DIODE-TRANSISTOR RING COUNTER. Tan, Z. C. (Univ. of Auckland, New Zealand). Nucl. Instrum. Methods, 74: 297-9(1969).

A ring counter which can operate at input frequencies from 0 to 250 MHz without any input pulse width, rise-time, or fall-time restrictions is described. (auth)

2529 TRANSFER MATRIX ANALYSIS OF γ-RAY TRANSMISSION CIRCULAR POLARIMETERS INCLUDING THE CONTRIBUTION OF SINGLE AND MULTIPLE SCATTERING. Mackie, R. D. L. (Univ. of Edinburgh); Byrne, J. Nucl. Instrum. Methods, 74: 268-76(1969).

The operation of γ-ray circular polarimeters based on transmission through magnetized iron has been analyzed using the formalism of the Stokes parameters and the transfer matrix. Expressions of quite general applicability have been derived for the transfer matrix elements which include the effects of single and multiple scattering in the transmitted beam and curves of the counting rate asymmetry as a function of γ-ray energy are presented for selected conditions of magnet length and detector energy acceptance. (auth)

2530 VERSATILE TWO-PHASE TRIGGER CIRCUIT. Brendle, M. (Univ., Tuebingen, Ger.). Nucl. Instrum. Methods, 74: 349-50(1969).

A trigger circuit with good recovery properties is described. It may be used as a gate generator, delayed gate generator, fast coincidence circuit, or frequency divider. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 3445, 3456, and 3457.

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 2403.

Basic Processes

Refer also to abstracts 2172 and 2747.

2531 (COO–1758-10) THYROID SECRETION RATE AND LACTATION. Anderson, Ralph R. (Missouri Univ., Columbia). [1969]. 16p. (CONF-690215–1). Dep. CFSTI.

From 5th Midwest Conference on the Thyroid, Columbia, Mo.

In rats and cattle, the thyroid hormone secretion rate was determined with the substitution method using subcutaneous injections of ^{131}I and thyroxine. An increase in TSR of 100% was observed in lactating rats. However, the low correlation coefficient of 0.2 between TSR and milk production served to indicate that the other six hormones known to influence milk synthesis or removal must also play a significant role in controlling the level of milk production. The correlation coefficient of 0.29 between TSR and milk production obtained from 32 observations in cows confirmed this concept. (H.B.G.)

2532 THE INSTITUTE OF ANIMAL TECHNICIANS (I.A.T.) MANUAL OF LABORATORY ANIMAL PRACTICE AND TECHNIQUES. SECOND EDITION. Short, D. J.; Woodnott, D. P. (eds.). London, Crosby Lockwood, 1969. 471p. 55s.

A chapter is included on techniques and practices in the use of radioisotopes. (UK)

2533 AN EVALUATION OF ^{57}Co-LABELLED VITAMIN B_{12} IN A DOUBLE TRACER TEST OF ABSORPTION USING A WHOLE-BODY MONITOR. Boddy, Keith; Will, George; Holmes, Barbara M. (Scottish Research Reactor Centre, Glasgow. Gateside Hospital, Greenock, Scotland). Phys. Med. Biol., 14: 455-62(1969).

Cobalt-57 labeled vitamin B_{12} (0.25 μg; 0.25 μCi) was used in a double tracer test of absorption, together with ^{58}Co-labeled vitamin B_{12} (0.4 μg; 0.4 μCi), using a whole-body monitor. It was found that variation of the counting-rate on the day of administration was small and was similar for both isotopes. The fraction of ^{58}Co γ rays detected in the ^{57}Co energy band also showed little variation and the patient was able to act as his own phantom. The range of absorption of vitamin B_{12} was 21.3 to 63.3% in control subjects and 1.8 to 11.8% in patients with pernicious anemia. The absorption of vitamin B_{12} with intrinsic factor, determined simultaneously, was always at least twice the absorption of vitamin B_{12} alone in patients with pernicious anemia and always less than twice in control subjects. The results demonstrate the suitability of ^{57}Co-labeled vitamin B_{12} in whole-body monitoring studies of vitamin B_{12} metabolism. (auth)

2534 RAPID CALCULATION OF RADIOIMMUNOASSAY RESULTS. Rodbard, David; Bridson, William; Rayford, P. L. (National Inst. of Health, Bethesda, Md.). J. Lab. Clin. Med., 74: 770-81(Nov. 1969).

Most methods available for expressing radioimmunoassay (RIA) results yield non-linear dose-response curves, making graphical or numerical dose interpolation difficult. Several methods were proposed for the linearization of dose-response curves in order to facilitate the rapid and accurate calculation of results with desk-top electronic calculators. The relations between these methods, their limitations, advantages, and ranges of applicability are reviewed. (auth)

2535 RADIOIMMUNOASSAY FOR BRADYKININ IN PLASMA AND SYNOVIAL FLUID. Talamo, Richard C.; Haber, Edgar; Austen, K. Frank (Massachusetts General Hospital, Boston. Robert B. Brigham Hospital, Boston). J. Lab. Clin. Med., 74: 816-27(Nov. 1969).

In order to determine endogenous bradykinin levels in biologic fluids, a method of processing was developed that avoids the artifacts of generation and destruction of bradykinin during the harvesting and processing of the fluids. Intrinsically labeled [^{14}C]-2,3-pro-bradykinin was employed to determine the recovery of native material and to demonstrate the validity of the method. A sensitive and specific radioimmunoassay for bradykinin was developed with the use of [^{125}I]-tyr^{0}-bradykinin as radiolabeled hapten, antibody harvested from rabbits immunized with bradykinin linked to ovalbumin via toluene di-isocyanate, and a dextran-coated charcoal method for separation of free hapten from antibody-bound radiolabeled hapten. This method has a sensitivity comparable to the rat uterus bioassay, in the 0.1 mμg range, but offers the advantages of immunologic specificity, reproducibility, and ease of performance of numerous samples simultaneously. The normal levels of plasma bradykinin were shown to be less than 3 mμg per milliliter; values of less than 3 mμg per milliliter were also observed in preliminary studies of synovial fluid from patients with osteoarthritis. (auth)

2536 TRACE ELEMENT DETERMINATION BY NEUTRON ACTIVATION ANALYSIS. Dear, B. D. Nucl. Energy, 138-46 (Sept.-Oct. 1969).

A method for the quantitative determination of trace elements in marine organisms is described. Comparative measurements of gamma spectra generated on a multi-channel analyzer were made using a new technique for peak area evaluation which was independent of relative spectrum drift. The method was applied to a study of the seasonal variation of the stable manganese content of Portugese oysters. (UK)

2537 REPLICATION OF A BACTERIAL EPISOME UNDER RELAXED CONTROL. Rownd, R. (Medical Research Council Unit, Cambridge, Eng. Univ. of Wisconsin, Madison). J. Mol. Biol., 44: 387-402(Sept. 28, 1969).

The replication of the R-factor NR1 in Proteus mirabilis was examined using the technique of analytical CsCl density-gradient centrifugation. As described previously, R-factors replicate under relaxed control in this genus, that is, there are multiple copies of this episome per host chromosome. The percentage of the NR1 DNA satellite band (1.718 g/cm^3) is constant throughout the exponential phase of growth and represents 10% of the host chromosomal DNA (1.700 g/cm^3). Since the size of NR1 DNA is approximately 1% of the size of the P. mirabilis chromosome, there appear to be about ten R-factors per host chromosome throughout the exponential phase. After entry into the stationary phase, the percentage of the R-factor DNA increases and reaches values as high as 60% of the chromosomal DNA. This finding suggests that R-factors continue to replicate for several hr during the stationary phase of growth. The mechanism of doubling of the multicopy pool of R-factors during exponential growth was investigated by transferring an exponential culture from ^{14}N-labeled medium to ^{15}N-labeled medium. The distribution of ^{14}N:^{14}N (light), ^{14}N:^{15}N (hybrid), and ^{15}N:^{15}N (heavy) R-factor DNA during the first generation in ^{15}N-labeled medium is consistent with a model in which individual copies of the R-factor are selected at random for replication without discrimination as to whether any particular copy was duplicated one or more times during that generation. A theoretical description of this model is derived in the Appendix. (auth)

2538 AUTORADIOGRAPHY OF WHOLE HUMAN CHROMOSOMES FOR ELECTRON MICROSCOPY. Zwillenberg, L. O.; Gloor, R. D.; Auf der Maur, P. (Univ., Bern). Z. Wiss. Mikrosk., 69: 22-5(July 1968). (In German).

An improved method was developed for labeling human chromosomes with ^3H and following the distribution of the isotope in the whole chromosome by electron microscopy. Lymphocyte cultures were treated with one μCi/ml of ^3H-thymidine for the last five hr of a 72-hr culture period. They were then fixed in ethanol-acetic acid and spread on slides coated with a carbon layer, which was hydrophilized by uv irradiation. The dipping technique using the Agfa–Gevaert emulsion Scinetia NUC 3.07 was then applied to the slides. A higher number of developed grains per radioactive site and an improved resolution, as compared to autoradiography using emulsions with coarser grains, were noted as advantages over conventional procedures used for light microscopy. (auth)

2539 LOSS OF RADIOACTIVITY DURING STORAGE OF ^{14}C-LABELED PHYTOPLANKTON ON MEMBRANE FILTERS. Wallen, D. G.; Geen, G. H. (Simon Fraser Univ., Burnaby, British Columbia). J. Fish. Res. Board Can., 25: 2219-24 (Oct. 1968).

It was shown that in the radioassay of phytoplankton production, substantial loss of ^{14}C activity may occur during storage. In the measurement of phytoplankton production with $^{14}CO_2$ it is standard practice to store labeled phytoplankton on membrane filters for later counting. This eliminates the need for counting facilities on board ship or at remote field stations. The storage loss of ^{14}C activity from natural populations of marine and freshwater phytoplankton as well as algal cultures was measured. When the cells were stored on a membrane filter in a desiccator, most of the

^{14}C loss occurred within the first 24 hr of storage. Little change in activity was recorded between 24 and 48 hr or 8 weeks storage. The loss of activity was independent of storage conditions. However, the loss of activity, which ranged from 2.9 to 50.7% of original activity, was related to the species composition of the phytoplankton. Chlorella lost the smallest percentage of the original activity, Scenedesmus the largest. Two alternative methods of handling the freshly filtered phytoplankton should eliminate the loss of activity experienced during storage. The ^{14}C material could be combusted and the activity measured in gas phase or the cells could be placed in a vial of scintillator and activity determined in a scintillation counter. (BBB)

2540 COMPARISON OF THREE ISOTOPIC METHODS FOR THE STUDY OF CALCIUM ABSORPTION. Agnew, J. E.; Kehayoglou, A. K.; Holdsworth, C. D. (Royal Free Hospital, London), Gut, 10: 590-7(July 1969).

The value of plasma ^{47}Ca levels as an indication of ^{47}Ca absorption was reassessed by comparing results obtained using this method with those obtained in the same subjects by the use of a simple whole-body counter. In addition, the validity of the whole-body counting method was assessed by comparing the results with those obtained by measuring fecal radioactivity. The 3 methods were compared in normal subjects, and in patients with various disorders of Ca absorption and metabolism. After an overnight fast, 10 μCi of $^{47}CaCl_2$ in distilled water with 10 mg of carrier Ca was administered orally. The results obtained by using a single-crystal whole-body counter correlated well with those obtained using carefully checked 7-day collections of stools and urine. The rare patient whose unusually large urinary excretion of ^{47}Ca invalidates a whole-body counter method of studying absorption can be detected by a single 24-hr urine collection after the oral dose. The percentage excretion in the urine of orally administered ^{47}Ca did not correlate with the amount absorbed but the ratio of urinary to absorbed ^{47}Ca correlated with the percentage urinary excretion of an intravenously administered load of stable Ca. Plasma levels of ^{47}Ca correlated poorly with more direct measurement of ^{47}Ca absorption. The ^{47}Ca levels rose slowly during the first 3 hr after the oral dose in patients with poor absorption, but reached a peak at 1 hr in normal subjects. The ^{47}Ca decays with a half-life of 4.7 days to ^{47}Sc (half-life 3.45 days) which emits both β and γ radiation. Commercially available ^{47}Ca usually contains up to 10% of the β-emitting isotope ^{45}Ca. The whole-body radiation dose to the patient from an oral dose of 10 μCi ^{47}Ca, including the contributions from ^{47}Sc and ^{45}Ca, is less than 0.2 rad, i.e., very much less than that arising from many diagnostic radiographic procedures. The short life of ^{47}Ca makes it ideally suited for absorption studies that can be repeated after a few weeks without the need to allow for any radioactivity remaining from the previous test, and with a radiation dose well within permissible limits. (BBB)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 2257, 2675, and 2718.

2541 (IN-1310, pp 31-4) HEALTH AND SAFETY RESEARCH. (Idaho Nuclear Corp., Idaho Falls).

Improvements in apparatus and techniques for studies on permeation of radioactive iodine or iodine compounds through the skin are described. Measurements were made on the epidermal layer of excised skin; materials passing through this layer were rapidly absorbed into the body's circulatory system. Penetration measurements made using separated epidermal layers were found to correspond with measurements made in vivo. A diagram of the apparatus for excised skin is presented. The usefulness of a time sharing computer terminal to simplify the preparation of routine Health and Safety Branch reports is being investigated. (H.L.W.)

2542 (NYO-2778-7) EFFECTS OF ^{3}H-THYMIDINE AS A DNA LABEL IN THE RAT LIVER. Progress Report. Post, Joseph (New York Univ., N. Y.). Sept. 1, 1969. Contract AT(30-1)-2778. 28p. Dep. CFSTI.

Studies were conducted on the effects of different doses of ^{3}H-TdR on the renewal patterns of normal and tumor cells. This method provided several experimental advantages. Used in vivo, it permitted the comparison of coexistent replicating populations of cells within the same host. Since the alterations are in labeled cells, they may be followed as specific populations in autoradiographs. By varying the label dose within a range that is sublethal to these populations, relatively subtle changes were produced in the cycle patterns. In the course of these studies unique properties of renewal patterns of normal and tumor cells were found. Some of these were applied to the problem of the control of proliferation of experimentally induced, autogenous tumor cells in vivo. This design was used as a model for the control of human cancer cell proliferation. Some information was gathered concerning amounts of radiation absorbed by the labeled nuclei under experimental conditions, and comparisons were made with the effects of x and γ radiation. Three replicating normal cell populations were investigated: liver, ileal cells, and spleen lymphocytes. In addition, studies were made on the formation of splenic megakaryocytes in young rats and the effects thereon of internal radiation. (auth)

2543 (NYO-4039-1) FISSION PRODUCT METABOLISM AND RESPONSE IN LABORATORY AND DOMESTIC ANIMALS AND PLANNING STUDY FOR EVALUATION OF RADIOACTIVE CONTAMINATION OF THE FOOD CHAIN. Progress Report, January 1, 1968-June 30, 1969. Comar, C. L. (New York State Veterinary Coll., Ithaca). Contracts AT(30-1)-2147; AT(30-1)-4039. 162p. Dep. CFSTI.

Sixteen separate abstracts were prepared for inclusion in NSA. Two additional studies are presented: the calcium-binding protein (transcalcin) and alkaline earth absorption; and glycol methacrylate as an embedding medium for light microscopy. (C.O.)

For abstracts of individual papers see: 2136, 2318, 2544-2548, 2597-2599, 2649, 2657, 2728, and 2774-2776.

2544 (NYO-4039-1, pp 12-16) SELECTIVE INCORPORATION OF ^{90}Y BY SPERM AND EMBRYOLOGICAL CONSEQUENCES. Casarett, Alison P.; Coomes, Roger K. (New York State Veterinary Coll., Ithaca).

Rat sperm incubated in vitro in an equilibrium mixture of ^{90}Sr-^{90}Y can selectively incorporate yttrium over strontium and other radionuclides into the tail segment; quantities were estimated of the order of 10^{7} atoms of yttrium per sperm tail. Uptake may be partially related to surface area and is specific for sperm. Several experiments suggested that the incorporated yttrium is in colloidal form and that uptake requires metabolic activity. Embryological damage from fertilization with ^{90}Y-containing sperm was not observed at the levels used. (auth)

2545 (NYO-4039-1, pp 20-32) STRONTIUM RETENTION IN VARIOUS PARTS OF THE YOUNG DOG SKELETON. Craig, P. H. (New York State Veterinary Coll., Ithaca).

Large body burdens of bone-seeking radionuclides are known to cause tumors of the skeleton in both animals and man. Although many portions of the skeleton can be involved, tumors are particularly frequent in the skull and near the ends of the major long bones. A pilot study to outline the characteristics of ^{85}Sr retention in these and other parts of the skeleton is nearly completed. It was found that both teeth and ear bones incorporate and maintain very high concentrations of ^{85}Sr when the body burden is acquired during the formative stages of these structures. On the other hand, there is almost no incorporation after formation of these bones is complete. Similar behavior, but to a lesser degree, was observed in long bone shafts. Growing metaphyses incorporate extremely high levels on a comparative basis, but the activity is lost because of rapid turnover rate in these areas. These preliminary data show a good correlation between degree of initial deposition, retention, and site of incidence of strontium-induced bone tumors. This suggests that such tumors may be the product of high radiation dose to nonspecific bone cells, rather than the result of transformation of localized tumor-prone bone tissue. (auth)

2546 (NYO-4039-1, pp 39-46) DIETARY SUPPLEMENTS AS COUNTERMEASURES AGAINST INGESTED RADIOSTRONTIUM AND RADIOCESIUM. Wentworth, R. (New York State Veterinary Coll., Ithaca).

Some of the substances that show promise of reducing ^{90}Sr absorption and retention by animals and humans are sodium alginate, aluminum phosphate gel, calcium, phosphorus, and magnesium; ferric ferrocyanide appears useful for reduction of ^{134}Cs. These materials were fed to rats and to lactating cows and the alterations in strontium, calcium, and cesium metabolism observed. (auth)

2547 (NYO-4039-1, pp 47-52) TURNOVER OF RADIOCESIUM. Lengemann, F. W. (New York State Veterinary Coll., Ithaca).

The rate of loss of ^{134}Cs from 4-day-old rats is greatly different when they are nursing as compared to the period immediately after weaning when the nutrient intake is either a commercial rat diet or powdered whole milk. It was postulated that the potassium level of the diet might be one causal factor. Experiments reported here show that the potassium intake after weaning can have a marked effect on the rate of loss of ^{134}Cs being more marked in young than in adult rats. It was observed that ingestion of NH_4Cl increased cesium excretion in both weanling and mature rats but was more effective in weanlings. An investigation was made into the possibility of using Cs/K ratios or Cs/Na ratios as a means of

quantitating cesium metabolism as is done for radiostrontium. The experiments lasted 14 days and at that time only about 70% equilibrium was reached. Experiments should be run for longer periods of time in order to assess this approach. (auth)

2548 (NYO-4039-1, pp 99-112) STUDIES OF ^{131}I UPTAKE, RETENTION, AND REMOVAL IN FOOD PLANTS. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca).

Iodine-131 was applied as a spray (NaI solution) to various pasture and food plants to examine uptake, retention, and removal characteristics under controlled conditions. Comparisons were made between pasture and various types of plants in an effort to develop some inter-relationships or indicator mechanisms that could be utilized under emergency releases of radioactivity. Data show a pasture to leaf lettuce ratio of 2:1, a pasture to green bean ratio of 60:1 and a pasture to tomato ratio of 180:1. Distribution of ^{131}I on various plant parts indicated that the leaf and stem (or vine) portion received more than 80% of the activity. Time sequenced uptake in green beans showed an early 20 to 30% uptake pattern followed by an increase to the 50 or 60% level after 2 hr. Removal procedures (rinsing, boiling) were successful in eliminating 70 to 90% of ^{131}I activity for most vegetables tested. (auth)

2549 ABSORPTION OF ^{32}P BY THE HUMAN BLADDER. Mentasti, P.; Gagliardi, F. (Univ., Padua). Attual. Ostet. Ginecol., 13: 217-27(May-June 1967). (In Italian).

The absorption into the blood system of a trisodium phosphate solution labeled with ^{32}P, introduced into the bladder of 10 women of various ages, was studied. The results showed the rapid passage and sufficient accumulation of the radioisotope in the blood. The pattern of the passage varied, especially with the age of the patient. In women at advanced menopause there was a much greater initial absorption, but the total quantity of ^{32}P entering the blood stream was less than in younger women. The possible causes of these variations were discussed. (tr-auth)

2550 RELATIONSHIP BETWEEN ^{90}Sr CONCENTRATION IN BONE AND SKELETAL LOCALITY. Koizumi, Akira (Tokyo Univ.); Yoshizawa, Yasuo; Okudaira, Masahiko. Radioisotopes (Tokyo), 18: 437-9(Oct, 1969). (In Japanese).

The difference in concentration of ^{90}Sr in bones was investigated by means of radiochemical analysis. The specimens were obtained from skull, sternum, rib, lumbar vertebrae, and pelvis of thirteen Japanese male adults. The mean value of the concentration of ^{90}Sr in each bone was: 0.33 ± 0.08 SU in skull, 1.75 ± 0.66 SU in sternum, 0.96 ± 0.23 SU in rib, 1.42 ± 0.30 SU in lumbar vertebrae, and 1.40 ± 0.29 SU in pelvis. It was found that the difference between the ^{90}Sr concentrations in bones in two skeletal localities was significant with regard to all possible combinations but the one of vertebrae and pelvis. (auth)

2551 RESEARCH ON THE PRESENCE AND DISTRIBUTION OF ^{90}Sr IN BONES OF BIRDS. Mascia, Carlo (Univ., Cagliari, Italy). Minerva Fisiconucl., 11: 172-7(1967). (In Italian).

By a first analytical research series on the bones of migratory birds, a hot zone from ^{90}Sr in the posterior feet is localized. On the basis of these results, the course of ^{90}Sr after administration to chicks is followed and the elective and maximal localizations in the distal zone of the skeleton are confirmed. (auth)

2552 INHIBITION BY STEROIDS OF PARATHYROID HORMONE-INDUCED ^{45}Ca RELEASE FROM EMBRYONIC RAT BONE IN VITRO. Stern, Paula H. (Northwestern Univ., Chicago). J. Pharmacol. Exp. Ther., 168: 211-17(Aug. 1969).

The effects of testosterone, 17-β-estradiol, hydrocortisone, and cholesterol on ^{45}Ca release by embryonic bone in organ culture were studied. Embryonic rat long bones were prelabeled with ^{45}Ca. Bone resorption was produced with parathyroid hormone and was quantified as release of ^{45}Ca from the paired bones. Steroids were added over a 10^{-9} to 10^{-5} M concentration range. All of the steroids at the highest concentrations tested (10^{-6} to 10^{-5} M) inhibited the response to parathyroid hormone. At these concentrations several steroids also inhibited ^{45}Ca release in the absence of parathyroid hormone. At intermediate concentrations (1.5×10^{-8} to 10^{-6} M), hydrocortisone, corticosterone, testosterone, and cholesterol all showed some inhibition. At concentrations less than 1.5×10^{-8} M, only dexamethasone was inhibitory. The inhibition produced by dexamethasone could be antagonized by increasing the concentration of parathyroid hormone. At concentrations achieved in vitro, glucocorticoids can inhibit bone resorption by a direct effect on bone. The in vitro inhibition of bone resorption produced by steriod hormones at high concentrations is a nonspecific effect. (BBB)

2553 NONHOMOGENEOUS WASH-OUT CONDITIONS OF ^{133}Xe FROM ADIPOSE TISSUE. Nielsen, S. Levin (Univ. of Copenhagen). Acta Physiol. Scand., 76: 10A-11A(May-June 1969).

Whether the clearance rate of ^{133}Xe from adipose tissue is constant and whether there is correlation between the calculated blood flow and the directly measured flow were studied. The inguinal subcutaneous adipose tissue in rabbits was isolated with intact blood supply and then covered by a gas-tight polyethylene membrane. The venous effluent was continuously measured by a drop recorder unit and the blood was returned to the animal through an open reservoir. The blood-to-tissue partition coefficient for ^{133}Xe was determined from the solubility in the blood and tissue components. Xenon-133 activity was registered by a scintillation crystal. Results showed that calculation of the adipose tissue blood flow from the externally registered ^{133}Xe wash-out curves from saturated tissue gives correct values for the blood flow. This means that the clearance is flow-limited. However, the initially faster clearance rate after bolus injection showed that the wash-out conditions for ^{133}Xe from adipose tissue are not homogeneous. Shunting by diffusion might explain this finding, as found for muscle, although the vascular structure in adipose tissue should favor complete mixing within the system. (BBB)

2554 CONSEQUENCE OF RIGHT CERVICAL SYMPATHETIC CHAIN EXTIRPATION ON THYROID ^{131}I UPTAKE IN THE ADRENALECTOMIZED FEMALE RAT. Kurten, B.; Schaefer, H.; Kraemer, H. Ann. Endocrinol. (Paris), 30: 407-12(May-June 1969). (In French).

Thyroid ^{131}I metabolism was studied in 80 female rats aged 45 to 50 days operated on as follows: extirpation of the right cervical sympathetic chain (16 animals); bilateral simultaneous adrenalectomy (32 animals); and both operations (adrenalectomy the day after sympathectomy. The ^{131}I uptake was measured in four animals of each of the five groups from two to seven days following surgery. Sympathectomy was followed by a significant increase of the ^{131}I uptake by the thyroid gland, predominantly in the right lobe. Bilateral adrenalectomy also increased the ^{131}I uptake, without any differences in the response from the sympathectomized group. The uptake was found to be particularly high in animals subjected to both operations. The difference between the right and the left lobe persisted in these animals. This effect was observed only in animals receiving saline to drink. In the other groups, the ^{131}I uptake decreased in parallel with the deterioration in their general condition following adrenalectomy. (BBB)

2555 MATEMATICHESKOE OPISANIE DINAMIKI PROTSESSOV RADIOAKTIVNOGO ZAGRYAZNENIYA MORSKIKH ORGANIZIMOV IZ VODNOI SPEDY. (Mathematical Description of the Dynamic Processes of Radioactive Contamination of Marine Organisms). Bachurin, A. A. Moscow, Atomizdat, 1968. 28p.

The mathematical model of the dynamics of the exchange of radionuclides between marine organisms and their environment is given. The following characteristics of the systems studied were determined; the analytical expression of transition characteristic for staircase-like perturbation, being the sum of two exponents, the rate of change of the function of accumulation in any moment of time for staircase-like perturbation, the transmission function of the system, the differential equation for the transition process when the concentration (activity) of the radionuclides in the environment is variable, the static coefficient of accumulation (K_c) constant to time (T_1) and (T_2), the time of the transition process up to the establishment of equilibrium (T_c), and the period of one-half accumulations (T_k). The analytical expressions that enter into the equations for the dynamics of isotopic exchange and also the rates of change of these quantities were determined and special cases of isotopic exchange were examined. The exchange of chemical elements between seawater and the environment was observed to check the correctness of the theoretical discussions. (tr-auth)

2556 THYROID UPTAKE OF ^{131}I FROM SKIN EXPOSURE. Murray, J. L. (Battelle-Northwest, Richland, Wash.). Health Phys., 17: 730-1(Nov. 1969).

To estimate the potential uptake through skin, a 150 cm^2 skin area on each of four miniature swine was exposed to ^{131}I vapor. A 150 cm^2 abdominal skin area on each of four additional swine was exposed to ^{131}I in solution (85% $^{131}I_2$, 15% Na ^{131}I). Initial deposition in both experiments ranged from 41 to 93 μCi, as monitored with a 2 × 2 in. NaI crystal scintillation probe. The results of subsequent skin and external thyroid monitoring are summarized. Better than 95% of the ^{131}I deposited from solution was removed by washing. Thyroid ^{131}I content reached maximum within 1 to 2 days in the solution-exposed animals, but increased through 5 to 6 days in the vapor-exposed animals, due to the much greater skin retention of ^{131}I in unwashed animals. (UK)

2557 THIOPENTAL-^{35}S: SYNTHESIS, ISOTOPE DILUTION ANALYSIS, AND METABOLISM IN RAT. Kunugi, Akira; Nagase, Yuzo (Tokyo Coll. of Pharmacy). Yakugaku Zasshi, 89: 1199-1204(Sept. 1969). (In Japanese).

Thiopental-^{35}S having a specific radioactivity of 13.2 mCi/mmole was synthesized from $H_2{}^{35}SO_4$ as the starting material through $H_2{}^{35}S$ and thiourea-^{35}S. Radiochemical and chemical yields from $H_2{}^{35}SO_4$ were 80.3 and 85.7%, respectively. The isotope dilution analysis for the determination of commercial thiopental sodium preparations was investigated with the ^{35}S-labeled thiopental, and it gave the mean recovery of 99.60 ± 0.68%. This method was advantageous over other known official methods such as ultraviolet absorptiometry and gravimetric analysis in the precision and selectivity of the method. As the metabolites of thiopental in the liver of male rats, methionine, thiourea, inorganic sulfate, and several unidentified ^{35}S-containing compounds were recognized by radiopaperscannography or reverse isotope dilution method. Metabolic rates of thiopental-^{35}S in rat liver were 0, 49.7, 59.2, and 60.2% at 15, 30, 90, and 120 minutes after its intraperitoneal injection, respectively. It was shown that a considerable amount of radioactivity arising from the injected ^{35}S-labeled thiopental was distributed in rat brain within 15 minutes after its intraperitoneal administration, and the rapid reduction in radioactivity was found to be three-fifths of the original during the following 15 minutes. (NSA of Japan)

2558 THE UPTAKE OF ^{131}I BY THE THYROID GLAND OF RABBITS DURING CHLOROFORM NARCOSIS. Nazarkin, A. I.; Popov, T. A. Vestn. Akad. Nauk Kaz. SSR, No. 8, 56-9(Aug. 1968). (In Russian).

Experiments were conducted on 34 pubescent female rabbits to determine the influence of narcotic substances on the function of the thyroid gland. Iodine-131 (2 μCi) was used as the indicator of thyroid function in the study. The radiometric data indicated that the capability of the thyroid gland to absorb ^{131}I during chloroform narcosis was significantly decreased. In the post-narcotic period a slow reduction of this capability was noted. (tr-auth)

2559 BINDING OF GALLIUM BY BLOOD SERUM. Hartman, Ronald E.; Hayes, Raymond L. (Oak Ridge Associated Universities, Tenn.). J. Pharmacol. Exp. Ther., 168: 193-8(July 1969).

The possibility of using ^{68}Ga or ^{72}Ga as a scanning agent for detection of bone malignancies was studied on the basis of the capacity of serum to bind Ga. Ultrafiltration, gel filtration, and equilibrium dialysis were used to test the hypothesis that the lack of early specific localization in bone at low levels of Ga (citrate form) is due to binding of Ga by serum components. Under such conditions Ga would not be readily available for concentration in bone. It was shown that ^{68}Ga ($T_{\frac{1}{2}}$—68 min) can be used as a scanning agent for the detection of bone lesions when sufficient carrier Ga is administered. The data confirmed that the high blood levels of Ga observed at early time periods (hours), when small quantities of Ga are intravenously administered, are due to its binding by serum constituents. Ultrafiltration studies suggested that the Ga-binding component has a molecular weight greater than 10,000. Studies with gel filtration indicated that the binding component belongs to the class of 280-nm absorbing materials with a molecular weight greater than 5000. Equilibrium dialysis experiments also suggest that a high molecular weight component in the serum is responsible for Ga binding. The percentage of added Ga (citrate) bound by rabbit serum decreased at concentrations above 3.6×10^{-2} μmole/10 ml of serum and dropped to 4% at 7.2 μmole/10 ml. Increasing the concentration of citrate caused a drop in Ga binding by serum but only at relatively high citrate concentrations. Binding was relatively insensitive to pH change at pH greater than 6.5. (BBB)

2560 RETENTION OF MERCURY IN THE BRAIN OF RABBIT AFTER INTRAVENOUS OR SUBCUTANEOUS INJECTION OF SUBLIMATE. Miyama, Tomoyo; Murakami, Masataka; Suzuki, Tsuguyoshi; Katsunuma, Haruo (Tokyo Univ.). Ind. Health (Kawasaki, Jap.), 6: 107-15(Oct. 1968).

Differences in the amount of ^{203}Hg in the brain of rabbit were studied after administration of sublimate solution by different routes. Irrespective of dose level and time after injection, subcutaneous injection resulted in a higher concentration of ^{203}Hg in the brain than did intravenous injection. After intravenous injection, the amount of ^{203}Hg retained in the liver was markedly higher than after subcutaneous injection. On the contrary, the kidney had a higher concentration of ^{203}Hg after subcutaneous injection. Urinary and fecal excretions of mercury up to 96 hr after injection were also determined. At the doses of 1.0 and 1.5 mg Hg/kg, the amount of ^{203}Hg excreted in urine was slightly higher after intravenous injection than subcutaneous, but no significant difference was seen for the fecal excretion of ^{203}Hg. A rabbit injected intravenously with a dose of 0.5 mg Hg/kg, in which an obstructive lesion of the urethra was found by postmortem examination, showed less urinary and fecal excretion of ^{203}Hg. Possible mechanisms for producing such differences in the mercury concentrations in the brain were discussed. (BBB)

2561 AUTORADIOGRAPHIC STUDIES BY THE STRIPPING FILM TECHNIQUE ON THE RADIOACTIVITY IN THE TISSUE OF RATS WITH TRANSPLANTABLE GUERIN EPITHELIOMA. Majewski, Czesław; Kubiak, Eugeniusz (Strusia City Hospital, Poznan, Poland). Patol. Pol., 19; 305-13(Apr-Jun 1968). (In Polish).

In 32 Wistar rats weighing 200 to 250 g, beryllium hydroxide and thorium nitrate solutions were introduced into the stomach through a tube, and their tissues were studied by the stripping film technique of autoradiography. Thorium nitrate was used to ascertain whether radioactivity would be increased to an appreciable degree in the stripping film technique, and beryllium hydroxide to study the influence of beryllium on intensity of radioactivity in the liver in healthy rats and in rats with transplantable Guerin epithelioma. The results showed that introduction of beryllium into the body, for unknown reasons, increases the number of silver grains of the emulsion over the nuclei and cytoplasm of liver cells. In the kidneys, which were also studied, a similar increase in the number of reduced silver grains in the emulsion was observed, as compared with animals not treated with beryllium. (BBB)

2562 THE EFFECT OF PROLONGED BREAST-FEEDING ON RADIOCESIUM RETENTION IN YOUNG RAT. Ichikawa, Ryushi (National Inst. of Radiological Sciences, Chiba, Japan); Inaba, Jiro; Matsusaka, Naonori. J. Radiat. Res., 10: 88-93 (June 1969).

Reasons for the higher retention of ^{137}Cs in the suckling than in the weanling rat were investigated. Rat pups, that were given ^{137}Cs previously, were divided into two groups at 21 days of age, i.e., at the normal weaning age. One group was weaned to the usual solid diet at this age, whereas the other group was kept under breast-feeding for one to two weeks longer beyond this normal weaning time. The latter group showed higher retention of ^{137}Cs than the former. The dietary difference should be at least one of the most important factors associated with the long biological half-life of this nuclide in the suckling rats. However, the elevated body retention in the rats of prolonged breast-feeding was still less than in the suckling rats of early days after birth. Therefore, the high retention of ^{137}Cs in the normal suckling rats may not be fully explained by breast-feeding alone. (auth)

2563 THE EFFECT OF POTASSIUM, LACTOSE, AND THYROXINE ADMINISTRATION ON RADIOCESIUM RETENTION IN YOUNG RAT. Inaba, Jiro; (National Inst. of Radiological Sciences, Chiba, Japan); Matsusaka, Naonori; Ichikawa, Ryushi. J. Radiat. Res., 10: 94-100(June 1969).

Some factors affecting ^{137}Cs retention in young rats were investigated to study the characteristic features in the metabolism of the nuclide in the rats of early stage of growth. Supplement of potassium accelerated ^{137}Cs removal from sucklings but slightly from weanlings. Weanling rats fed on lactose-supplemented diet showed somewhat higher retention of the nuclide than that in the control rats. Daily administration of thyroxine to suckling rats increased removal of body ^{137}Cs. However, this effect began to appear about ten to twelve days after the beginning of the administration of thyroxine in the case of 7-day-old sucklings (age at the beginning of experiment), whereas it appeared within a few days in the case of 17-day-old ones. (auth)

2564 EFFECT OF SOME DIETARY ADDITIVES ON CALCIUM AND STRONTIUM ABSORPTION IN SUCKLING AND LACTATING RATS. Kostial, K.; Durakovic, A.; Simonovic, I.; Juvancic, V. (Inst. for Medical Research, Zagreb). Int. J. Radiat. Biol., 15: 563-70(1969).

The effect of calcium, phosphate, and alginate additives to the diet on ^{47}Ca and ^{85}Sr absorption from the gut was investigated in suckling and lactating rats. Suckling rats aged 5 to 7 days were artificially fed on cow's milk (8 hr a day during a period of 10 days) containing tracer amounts of ^{47}Ca and ^{85}Sr to which various amounts of calcium, phosphate, and alginate were added. Variation in the calcium by seven-fold and in the phosphate by five-fold caused only minor changes in the absorption of radiostrontium from the gut and no changes in the percentage ^{47}Ca absorption. The results indicate that the total absorption of calcium was independent of the phosphate level and proportional to the calcium concentration in the milk. The addition of alginate to milk caused a two-fold reduction in radiostrontium retention by suckling rats without affecting calcium absorption from the intestine. The increased strontium absorption normally found in lactating rats was prevented by supplementing the maternal diet with calcium, phosphate, and

alginate but without affecting the increased calcium absorption. (auth)

2565 ULTRASTRUCTURE AND AUTORADIOGRAPHY OF ISOLATED THYROID CELLS INCUBATED IN THE PRESENCE OF ^{125}I. Tixier-Vidal, A.; Picart, R.; Rappaport, L.; Nunez, J. (Coll. de France, Paris). J. Ultrastruct. Res., 28: 78-101(July 1969).

Metabolism of radioiodine by thyroid cells was studied at the ultrastructural level. Sheep thyroid cells were isolated by trypsinization and cultured in Parker's medium containing 1 mCi/ml ^{125}I. Radioiodination of thyroid constituents was studied by chromatography, proteins being separated on Sephadex G-25, and the cells were examined by electron microscopy and autoradiography. Excellent preservation of thyroid cells was obtained by the methods described. The cells were found to lose their polarity when separated by trypsinization, but the dissociated cells partially reaggregated during incubation. It was found that ^{125}I was incorporated into protein principally in the rough membrane structures. There was no preferential attachment of ^{125}I to the cellular membrane. Radioiodinated thyroglobulin was demonstrated as well as more lightly ^{125}I-labeled proteins. The results indicated an intracellular site for the radioiodination of thyroglobulin. (BBB)

Radiation Effects

Refer also to abstracts 2644, 2719, 2758, and 2867.

2566 (AEC-tr-6717) PHOTOCHEMISTRY AND LUMINESCENCE OF PROTEINS. Vladimirov, Yu. A. Translation of Fotokhimiya i Lyuminestsentsiya Belkov, Izdatl'stvo Nauka, Moscow, 1965. 207p. (TT-69-55013; IPST-Cat-5448). Dep. CFSTI.

The contents of this book are presented in three parts: luminesof proteins (6 chapters); migration of energy in protein systems (2 chapters); and photochemical processes in proteins and aromatic amino acids (5 chapters). A foreword, conclusion, and comprehensive bibliography are included. (C.O.)

2567 (NYO-3797-7) PROGRESS REPORT [ON X-RAY INACTIVATION OF PHAGES], JANUARY 1-AUGUST 31, 1969. Freifelder, David (Brandeis Univ., Waltham, Mass.). Sept. 26, 1969. Contract AT(30-1)-3797. 2p. Dep. CFSTI.

A summary of a 3 yr progress report is presented. Glycerol protected bacteriophages against x-radioinduced inactivation. The dose reduction factor for single-strand breakage was 1.3, for double-strand breakage 2.4, and for base damage 3.2. Neither 5'P nor 5'OH groups were detected in x-irradiated phage DNA using assay by polynucleotide kinase or DNA ligase. It was concluded that x radiation does not induce a simple phosphoester break. Work is in progress on radiation effects on phage injection and on the structure and transcription of phage DNA. The effects of thymine starvation on phage DNA are also under investigation. (M.M.B.)

2568 LATE EFFECTS OF IONIZING RADIATION ON THE ACTIVITY OF CEREBRAL PP-ASE. I. Ghizari, Eugenia. Stud. Cercet. Fiziol., 14: 149-54(1969). (In Rumanian).

The activity of inorganic pyrophosphatase in the brain of mice was studied following x irradiation at doses of 25 to 1000 R at different time intervals. It was found that large doses (above 125 R) inhibited the enzyme. Small doses (25 and 50 R) had an activating effect on the enzyme which was manifested after two days of irradiation and was maintained for 12 days. (tr-auth)

2569 USE OF LASERS IN BIOLOGICAL RESEARCH. Rubin, L. B. (Moscow State Univ.). Usp. Sovrem. Biol., No. 2, 222-34(1969). (In Russian).

Basic principles and technical characteristics of laser radiation are discussed and some of the practical applications in biological experimentation are given. Possible mechanisms of action on biological objects are analyzed in some detail. Laser radiation possesses a number of characteristics, monochromatic quality, great energy, coherence, and brief duration of action, each of which may play a part in the manifestation of the specific forms of interaction with biological objects. The preliminary findings indicate that laser radiation has a powerful effect on such intracellular processes as respiration and oxidative phosphorylation, protein and nucleic acid synthesis, photosynthesis, and functioning of the nuclear apparatus. (JPRS)

2570 HISTOCHEMICAL, BIOCHEMICAL, AND ELECTRON MICROSCOPIC CHARACTERISTICS OF THE OVOPOIETIC ORGANOID AFTER X-RAYING. Bojadzieva-Mihajlova, A. G. Izv. Inst. Morfol., Bulg. Akad. Nauk., 13: 147-56(1968). (In Bulgarian).

Changes in the ovopoietic system of newborn white mice exposed to 600 to 1200 R of x radiation were investigated by electron microscopic, histochemical, and biochemical methods. During the latent period, no morphological changes could be detected either at cellular or at subcellular levels, while by electron microscopy the following changes were detected in the nucleus: pulverization of the deoxyribosomial apparatus and focal aggregation of the single particles followed by agglomeration manifested by a more contrast electro-pattern in microscopy. The last result was picnosis, identical with that observed by light microscopy. These changes were expressed histochemically by obtaining free histones and pyroninophilia, and biochemically by a relative increase of RNA and all free proteins. It was concluded that the changes in the nucleus present an early and characteristic pattern of the effects of radiation. (Abstr. Bulg. Sci. Med. Lit.)

2571 ELECTROPHORETIC CHARACTERIZATION OF ϕX174-SPECIFIC PROTEINS. Gelfand, David H.; Hayashi, Masaki (Univ. of California, San Diego, La Jolla). J. Mol. Biol., 44: 501-16(Sept. 28, 1969).

An acrylamide gel electrophoresis assay for ϕX174-specific proteins synthesized in vivo is described. By infecting uv-irradiated hosts (Escherichia coli HF4704 HCR$^-$) with amber mutants in each of seven complementation groups, it was possible to identify several ϕX174-specific proteins. (auth)

2572 STUDIES ON ϕX174 PROTEINS. I. PHAGE-SPECIFIC PROTEINS SYNTHESIZED AFTER INFECTION OF ESCHERICHIA COLI. Burgess, Ann B.; Denhardt, D. T. (Harvard Univ., Cambridge, Mass.). J. Mol. Biol., 44: 377-86(Sept. 28, 1969).

By the use of polyacrylamide gel electrophoresis, the presence of five ϕX174 specific proteins was shown in uv-irradiated ϕX-infected cells of Escherichia coli. An additional protein was resolved by electrophoresis of dissociated phage particles. Four of these six proteins were components of the phage coat and had molecular weights of 48,000, 36,000, 19,000, and about 5000. The other two proteins were the products of cistrons I (lysis) and V (required for single-stranded DNA synthesis) and had molecular weights of 10,000 and 15,000 respectively. The cistron VI protein, that is necessary for parental replicative form replication, was not detected. (auth)

2573 TARGET MOLECULAR WEIGHT OF MITOCHONDRIAL ATPASE. Kagawa, Yasuo (Shinshu Univ., Matsumoto, Japan). J. Biochem. (Tokyo), 65: 925-34(June 1969).

The target molecular weights of mitochondrial ATPase in the inner membrane in situ, in purified state, and in reconstructed membrane were determined by means of electron irradiation with a linear accelerator. The target molecular weights of mitochondrial ATPase were irrespective of its state and close to the molecular weight of purified mitochondrial ATPase determined with other methods than irradiation. The bead-like structure of the inner membrane of mitochondria, which may represent the ATPase molecule, was lost by irradiation. Those activities that depend on the conservation of high energy state, such as the respiratory control ratio, ^{45}Ca accumulation, and swelling contraction, were affected by the low irradiation dose, despite their relationships to the ATPase. (NSA of Japan)

2574 MYOCARDIAL CHANGES IN RABBITS FOLLOWING THEIR CHRONIC WHOLE-BODY IRRADIATION (KARYOMETRIC DATA). Vorb'ev, E. I.; Stepanov, R. P. Space Biol. Med. (USSR) (Engl. Transl.), 3: No. 2, 1-10(1969).

Translated from Kosm. Biol. Med., 3: No. 2, 3-9(1969).

The effect of chronic exposure of rabbits to ionizing radiation on their myocardium was examined. The animals were subjected to whole-body x irradiation with a dose of 20 R/day, receiving a total dose of 500, 1,500, and 2,400 R. The tissue changes were evaluated using histologic and karyometric techniques. On the tenth day after irradiation with any of the doses there was a decrease in the size of muscular nuclei against a background of interstitial edema, vascular hyperemia, and dystrophically changed muscle fibers. The decrease persisted for three to six months after the exposure. The development of myofibrosis in the myocardium was accompanied by the formation of muscle fibers with large and gigantic cells. This can be considered a manifestation of compensation and repair processes in the myocardium. (auth)

2575 CONTENT OF AMMONIA AND GLUTAMINE IN THE BRAIN UPON X-RAY IRRADIATION DURING INHIBITION OF THE FUNCTION OF THE ADRENAL CORTEX. Pikulev, A. T.; Tal'kovskaya, L. S. Dokl. Akad. Nauk BSSR, 12: 1048-9(Nov. 1968). (In Russian).

Data are presented on the content of ammonia and glutamine in brain tissue after whole-body x irradiation at a dose of 40 R, through 1 hr, 1, 2, and 3 days during inhibition of adrenal cortex function by repeated introduction of larger doses of hydrocortisone. It was established that under the conditions of the experiment,

there occurred a significant increase in the quantity of ammonia in all periods studied, most expressed in the first hour and days after irradiation. The quantity of glutamine following x irradiation of rats in which adrenal cortex function was inhibited was reduced. Statistical treatment of the data confirms the authenticity of the changes occurring toward the end of the first and second days. It was concluded that upon x irradiation of pharmacologically adrenalectomized rats in comparison with the irradiation of intact animals, not only is there an increase in quantitative shifts, but also in qualitative changes. (tr-auth)

2576 FATTY ACID–COENZYME-A COMPOUNDS IN MOUSE LIVER FOLLOWING WHOLE-BODY X IRRADIATION. Berndt, J.; Gaumert, R. (Univ., Freiburg i. B.). Experientia, 25: 16-17(Jan. 15, 1969). (In German).

The contents of fatty acid CoA derivatives were measured in mouse liver after whole-body x irradiation with 600 R. While the contents were also unchanged in fed mice, a decrease occurred in starved mice after irradiation. The results are discussed with respect to fatty acid synthesis. (tr-auth)

2577 SOME QUANTUM ASPECTS OF THE PROTEIN INTERMOLECULAR INTERFACES IN CONNECTIVE TISSUE. Hoerman, Kirk C.; Balekjian, Aram Y.; Boyne, Philip J. (National Naval Medical Center, Bethesda, Md.). J. Dent. Res., 48: Suppl., 661-70(Sept.-Oct. 1969).

From 4th International Conference on Oral Biology, Copenhagen, Denmark. See CONF-680726-(Pt.1, Suppl.).

Ultraviolet light-induced phosphorescence of collagen and globular protein in connective tissue was analyzed by spectral and kinetic studies. Computer resolution of the lifetimes of phosphorescent excited states of each protein, and their contribution to total luminous flux at zero time, constituted a means of simultaneous assessment of protein changes in cartilage, because of age, and because of regrowth of transplanted bone. (auth)

2578 INFLUENCE OF A RADIOMIMETIC (METHYLDICHLORODIETHYLAMINE) ON BIOSYNTHESIS OF FATS AND STEROLS BY YEAST ORGANISMS. Larikova, G. A.; Gal'tsova, R. D. (Inst. of Microbiology, Moscow). Microbiology (USSR) (Engl. Transl.), 37: 872-5(Nov.-Dec. 1968).

The combined effect of the radiomimetric methyldichlorodiethylamine (embichin) and ionizing radiation on the lipid metabolism of yeast cells was studied. Embichin added at concentrations of 0.1, 0.2, 0.3, and 0.5 mg/ml increased the lipid content of yeast cells. In cultures of Saccharomyces carlsbergensis the greatest increase in lipids was observed at an embichin concentration of 0.2 mg/ml and for S. cerevisiae at 0.3 mg/ml. The increase in lipids was greater than 100% in some instances. A similar effect with embichin was observed with respect to sterol formation. The optimum concentration for the increase in sterols was at 0.2 mg/ml. X irradiation alone substantially increased the yield of fats and sterols in yeasts. With combined treatment of yeasts, an additional increase in lipids and sterols was noted. The lipid content after the joint action of radiation and the radiomimetic agent was distinctly increased. The increase in lipids in S. carlsbergensis INMI-101 with such treatment was ~15 to 20% greater than the increase in the lipid level of cells that were only irradiated or yeasts treated with embichin alone. In S. carlsbergensis Frohberg the increase in lipids was 16% greater in comparison with the increase in cells only irradiated and 37% greater than the increase in lipids in cells treated only with embichin. In S. cerevisiae A the increase in lipids by irradiation and embichin was 87% greater than for irradiated samples and 60% greater with embichin alone. The increase in sterols was also enhanced under the combined action of radiation and radiomimetric: 12 to 15%, 27 to 28%, and 28 to 17%, respectively, over the increase of either agent acting alone. Embichin caused no appreciable changes in the composition of the lipid fraction of yeast cells as seen chromatographically. (BBB)

2579 IRRADIATION CLEAVAGE OF TRIMETHYLAMINE OXIDE IN FISH MUSCLE. Amano, K.; Tozawa, H. pp 467-71 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

The decomposition products from TMAO in fish by irradiation were studied from the viewpoints of both quality changes and wholesomeness. Gamma irradiation at dosages from 0.6 to 5.6 Mrad led to the formation of trimethylamine (TMA), dimethylamine (DMA), ammonia and formaldehyde (FA) in the flesh of fish rich in TMAO. The amounts of these decomposition products differed with dosage and with the species of fish treated. The quantities of each compound were not, however, large enough to raise the question of wholesomeness. Only the gadoid group indicated relatively higher levels of DMA and FA than other species such as shark (Deanis spp.) and squid (Sepiotenthis lessonia). It may be concluded that the precursor of DMA and FA is TMAO in fish, but ammonia may be derived from some nitrogenous compounds other than TMAO. In ordinary fish, various substances could be precursors of FA, but in the case of the gadoid fishes TMAO will be most likely to form FA on irradiation, since irradiation appears to enhance the biological production of FA and DMA from TMAO. As coexistence of TMAO and the enzyme system is found, the free radicals generated by irradiation may play a significant role in this specific enhancement. (auth) (UK)

2580 IRRADIATION EFFECTS ON THE BOUND WATER OF MAMMALIAN TISSUES. Kawamura, Fumio; Okamoto, Kazuo; Kobayashi, Jindo. Kawano, Satiko (Tokushima Univ., Japan). J. Radiat. Res., 10: 45-51(June 1969).

The effects of x irradiation on the bound water of living tissues, such as rat muscle, liver tissue, red cells, and mouse thymus tissue were studied by the vapor pressure method. The amount of bound water in various living tissues after irradiation changed appreciably from that in normal tissues. The experimental data were analyzed on the basis of the BET theory. The alteration in bound water on exposure might be related to change in the number of free polar groups capable of forming hydrogen bonds. (auth)

2581 ^{32}P-RETENTION OF DNA IRRADIATED IN A REACTOR. THE ENHANCEMENT OF THE RETENTION WITH INCREASING IRRADIATION TIME. Kawai, Kenichi; Waki, Asako; Akaboshi, Mitsuhiko; Iwata, Shiro (Kyoto Univ.). J. Radiat. Res., 10: 83-7(June 1969).

Phosphorus-32 in DNA irradiated under various conditions was examined. The retention was enhanced with increasing irradiation time when DNA containing appropriate amounts of H_2O was irradiated at −78°C. The enhancement was based on reactor irradiation, that is, some kinds of radiation (γ rays and fast neutrons) seem to contribute to this enhancement. The second irradiation immediately after the first irradiation had an effect of increasing ^{32}P retention, but after a prolonged interval, it failed to increase the retention. From these results, possible mechanisms of the phenomenon were discussed. (auth)

Immunology

Refer also to abstract 2792.

2582 PROTECTIVE IMMUNITY PRODUCED BY THE INJECTION OF X-IRRADIATED SPOROZOITES OF PLASMODIUM BERGHEI. V. IN VITRO EFFECTS OF IMMUNE SERUM ON SPOROZOITES. Vanderberg, J.; Nussenzweig, R.; Most, H. (New York Univ., N. Y.). Contract DA-49-007-MD-964. Mil. Med., 134: 1183-90(Sept. 1969).

From Panel on Experimental Malaria, Washington, D. C. See CONF-690538.

A precipitation was formed at one end of the Plasmodium berghei sporozoite after incubation in serum from animals immunized with x-irradiated sporozoites. The serum factor that induced this reaction appeared to be correlated with protective immunity. This factor increased after each booster injection, decreased gradually over a period of 3 months after completion of the immunization schedule, and appeared to be most active in sera from groups of animals that possessed a greater degree of protective immunity. Sporozoites of other species of rodent malaria, P. vinckei and P. chabaudi, also reacted in this sera, but only at lower serum dilutions than the homologous sporozoites. Sporozoites of avian malaria (P. gallinaceum) and simian malaria (P. cynomolgi) failed to react. (auth)

2583 PROTECTIVE IMMUNITY PRODUCED BY THE INJECTION OF X-IRRADIATED SPOROZOITES OF PLASMODIUM BERGHEI. IV. DOSE RESPONSE, SPECIFICITY, AND HUMORAL IMMUNITY. Nussenzweig, R.; Vanderberg, J.; Most, H. (New York Univ., N. Y.). Contract DA-49-007-MD-964. Mil. Med., 134: 1176-82(Sept. 1969).

From Panel on Experimental Malaria, Washington, D. C. See CONF-690538.

The immunization of mice with x-irradiated sporozoites of Plasmodium berghei produces, under appropriate circumstances, complete protection against an otherwise 100% lethal sporozoite inoculum. The partial protection obtained with a single immunizing dose can be increased with repeated immunizing injections, and by using larger numbers of irradiated sporozoites. A dose of 7.5×10^4 irradiated sporozoites (parasites obtained from 15 to 20 infected Anopheles stephensi), is sufficient, when repeated, to completely prevent the development of patent infections upon challenge. The incubation of sporozoites of P. berghei in sera from these immunized animals produces a considerable loss of infectivity of the

parasites, as detected by inoculation. Under these conditions there is a cross-reactivity of P. berghei-immune sera with sporozoites of P. vinckei. (auth)

2584 EXPERIMENTAL MALARIA. A Panel Workshop at Washington, D. C., May 13, 14, and 15, 1969. Sadun, Elvio H.; Moon, Arthur P. (eds.). Mil. Med., 134: 729-1306(Sept. 1969). (CONF-690538).

Separate abstracts were prepared for two papers presented at this conference. An additional 61 papers were presented on biochemical, cultivation, immunological, and serological aspects of malaria. (H.L.W.)

For abstracts of individual papers see: 2582 and 2583.

2585 THE ACTIVITY OF MOUSE KUPFFER CELLS FOLLOWING INTRAVENOUS INJECTION OF T4 BACTERIOPHAGE. Inchley, C. J. (New York Univ.). Clin. Exp. Immunol., 5: 173-87(Aug. 1969).

To investigate the role of Kupffer cells in the treatment of bacteriophage antigen during the inductive phase of the immune response, the localization, loss of viability, and catabolism of coliphage T4 within these cells were studied in normal and x-irradiated mice and compared to that in the spleen. In addition, antigen-laden Kupffer cells from immunized mice were transferred to syngeneic recipients to determine whether they carried any immunogenic stimulus that was available to lymphocytes and that could, therefore, be detected by the appearance of antibody in the hosts. Mice were irradiated at a dose rate of 66.4 R/min with 230-KV x rays. In mice exposed to doses of 450 and 600 R, 24 hr before administration of phage, the ability of the reticuloendothelial system (RES) to remove phage particles from the circulation was not impaired. The initial phagocytic indices (K = 0.053 after 450 R and 0.082 after 600 R) were similar to those for normal mice. In mice exposed to 450 and 600 R and killed at intervals up to 7 days after the injection of T4, when their spleens and perfused livers were assayed for surviving phage, the numbers were similar to those for normal animals. Irradiation with these doses, therefore, did not obscure the faster rate of phage inactivation within Kupffer cells. In control mice, phage was disposed of more rapidly in the liver than spleen, as measured by the disappearance of viable T4 particles and by the loss of radioactive label following injection of ^{131}I-T4. Antigen-containing Kupffer cells elicit little or no antibody synthesis on transfer into normal syngeneic recipients, or on incubation with lymphoid cells in vitro. Evidently these macrophages differ from other components of the RES in their treatment of T4 antigen, and may be concerned mainly with its breakdown and disposal rather than initiation of antibody synthesis. (BBB)

2586 THE IMMUNOGENICITY OF PHAGOCYTOSED T4 BACTERIOPHAGE: CELL REPLACEMENT STUDIES WITH SPLENECTOMIZED AND IRRADIATED MICE. Inchley, C. J. (New York Univ.); Howard, J. G. Clin. Exp. Immunol., 5: 189-98(Aug. 1969).

The role of phagocytosed antigen in the production of antibody to bacteriophage T4 was studied. The ability of mice to give an antibody response to this antigen was first impaired either by splenectomy or by x irradiation, and then restored by injection of syngeneic lymphoid cells given at various times relative to the injection of T4. The mice were exposed to 500 R whole-body irradiation, a dose sufficient to suppress the immune response to both T4 and sheep red cells, but not affecting the overall reticuloendothelial clearance and degradation of antigen. In splenectomized animals administration of lymphoid cells had only a marginal effect on the severely depressed response to T4, indicating that an intact spleen is essential to development of the normal immune response, and that circulating immunocompetent cells are unable to respond to circulating antigen or to antigen sequestered in the liver. On the other hand, in x-irradiated mice, the faster and more complete restoration of the anti-T4 response confirmed the ability of antigen in the spleen to stimulate competent cells. Immunogenicity of T4 within spleen was not lost at a rate that corresponded to its gross breakdown but persisted within decrease for at least 48 hr. (BBB)

2587 ACTIONS OF RADIATIONS ON HOST-VIRUS ONCOGENIC INTERACTION. II. Latarjet, Raymond (Pasteur Inst., Paris). Proc. Res. Inst. Nucl. Med. Biol., No. 10, 177-87(1969).

Injected irradiated homologous or isologous neoplastic tissues extracts were used for the treatment of about 30 cases of Hodgkin's disease, 13 cases of acute leukemia, 50 cases of lung cancer, and a few cases of reticular cell sarcoma in human patients. Clinical results are reported to be encouraging. There was no accident attributable to the injection of either isologous or homologous extracts, although a certain degree of hypersensitivity to the tissue extract appeared in some patients three to four weeks following intramuscular or intravenous injection of the tissue extracts. Preliminary studies are reported on immune reactions in hamsters and mice following the injection of uv- or x-irradiated virus-induced neoplastic tissue extracts from isologous or homologous donors. (C.H.)

2588 COPROANTIBODIES TO MILK: IDENTIFICATION BY RADIOIMMUNOELECTROPHORESIS. Kletter, B.; Freier, S.; Davies, A. M.; Gery, I. (Hebrew Univ., Jerusalem. Shaare Zedek Hospital, Jerusalem). J. Immunol., 103: 857-8(Oct. 1969).

Sera and fecal supernatants were obtained from infants with gastrointestinal milk sensitivity and tested by the radioimmunoelectrophoresis technique. Goat antiserum of monospecific antisera against immunoglobulins were used for development of precipitation lines and were followed by ^{125}I-labeled milk from which fat and casein were removed. A figure is presented to show the immunoelectrophoresis and the corresponding radioimmunoelectrophoresis reactions of sera and fecal supernatants from three milk-sensitive cases. The fecal supernatants contained relatively more IgA but less IgG than did the corresponding sera. IgM was also detected in the fecal supernatant of case 2. Specific antibody activity, demonstrated by the radioimmunoelectrophoresis test, was shown in the IgA fraction, with smaller amounts of antibody of the IgG type. Fecal supernatants from infants with other diseases, as well as from normal controls, showed very little or no antibody against milk by the radioimmunoelectrophoresis test. (H.L.W.)

2589 PATHOLOGICAL CHANGES IN RABBITS INJECTED WITH PASTEURELLA TULARENSIS KILLED BY IONIZING RADIATION. Finegold, Milton J.; Pulliam, James D.; Landay, Marshall E.; Wright, George G. (Fort Detrick, Frederick, Md.). J. Infect. Dis., 119: 635-40(June 1969).

Tissue changes were studied in rabbits injected with bacterial suspensions that contained 2×10^{11} viable organisms per ml and were exposed to 10^6 R of ^{60}Co γ radiation. After rabbits received from 3 to 9 ml of suspension in a single intravenous injection, the earliest deaths occurred at 11 hr. Thus, suspensions of Pasteurella tularensis killed by ionizing radiation were lethal for rabbits within 24 hr after intravenous injection of 6×10^{11} or more organisms. The major pathologic changes were extensive hemorrhagic necrosis of the spleen, focal coagulation necrosis of the liver, pneumonitis, and glomerular capillary occlusion by fibrin thrombi. Similar lesions were produced when two smaller doses of the suspension were given intravenously 24 hr apart. The localized Shwartzman reaction was produced by an intradermal injection followed in 24 hr by an intravenous injection. Rabbits were protected against the lethal action of the irradiated suspension and against development of glomerular thrombosis by prior administration of a single dose of 25 mg of cortisone. The pathological findings were similar to those in rabbits given endotoxins from meningococci or other gram-negative organisms and may be interpreted as a combination of the local and generalized Shwartzman reactions. Similarities were also noted between responses to the irradiated suspension and those occurring during experimental tularemia infection in rabbits. (BBB)

2590 EFFECTS OF RADIATION ON THE INITIAL AND ANAMNESTIC IgM HEMOLYSIN RESPONSES IN RABBITS: ANTIGEN INJECTION AFTER X-RAYS. Taliaferro, William H.; Taliaferro, Lucy Graves (Argonne National Lab., Ill.). J. Immunol., 103: 559-69(Sept. 1969).

The effects of a wide range of x rays from 25 to 700 R on the initial and anamnestic IgM hemolysin responses were ascertained in groups of rabbits by giving an intravenous initial injection or reinjection of $10^{8.3}$ fresh sheep red blood cells (SRBC)/kg rabbit from 4 hr to 2 months (and in some cases 6 months) after irradiation. Sera from the rabbits were titrated by the delicate 50% hemolysis endpoint and graphs of the responses were analyzed with respect to five parameters: length of the latent period, peak titer, length and rate of rise to peak titer and decline from peak titer. The following statistically significant modifications were revealed, as compared to corresponding initial and anamnestic responses in unirradiated control groups. On the one hand, the initial response, small doses of 25 and 100 R stimulated the prolonged production of hemolysin when SRBC were injected from 4 hr to a week thereafter and a transient high peak titer when SRBC were injected at 1 month after irradiation. On the other hand, 25 and 100 R did not stimulate the anamnestic response at all, but depressed peak titers when SRBC were given from 7 to 30 days thereafter. 25 and 100 R did not modify the length of the latent period in either response. Large doses of 500 and 700 R equally and intensively depressed both responses when SRBC were given from 4 hr to 2 days thereafter. Such responses were characterized by prolonged latent periods and prolonged hemolysin rises at low rates of rise to depressed

peak titers. Recovery from the depressing effects of 500 and 700 R began when SRBC were given 7 days after irradiation, but was more delayed in the anamnestic response than in the initial response. The foregoing differences between the initial and anamnestic hemolysin responses in rabbits, stimulated with relatively small amounts of Forssman antigen after irradiation, suggest that the immunologically competent initial cells, as compared to the activated memory cells, are more easily stimulated and less sensitive to injury, and that both types of cells are modified to a greater extent during induction than during later stages of proliferation and synthesis. (auth)

2591 ANTIBODY PRODUCTION IN MICE. I. THE ANALYSIS OF IMMUNOLOGICAL MEMORY. Hamaoka, T.; Kitagawa, M.; Matsuoka, Y.; Yamamura, Y. (Osaka Univ.). Immunology, 17: 55-69(July 1969).

Development of immunological memory was analyzed by an in vivo culture technique. Lymphoid cells from primed mice were transferred into heavily x-irradiated recipients and the size of memory cell population in primed donor mice was estimated by the magnitude of secondary responsiveness. To study the effect of the x irradiation of recipients on antibody-forming capacity of transferred memory cells after antigenic stimulation, the primed cells were transferred intravenously into 5 groups of 600-R irradiated recipients and then antigenic stimulation was given 0, 9, 16, 23, or 30 days after cell transfer. The transferred cells produced antibody in secondary response fashion in every group. The antibody titers when mice were stimulated by antigen 9 to 30 days after cell transfer were slightly lower than those stimulated immediately, although all of these titers were higher than those of recipients nonirradiated, but stimulated immediately. Therefore, the transferred cells still survived in the recipients in chimera state for at least 30 days. Development of memory cells carrying information for synthesis of γG_1 antibodies (γG_1-memory cells) was initiated at an early stage of priming and following by that of the γG_2-memory cells. Although the ratio of population of γG_2- to γG_1-memory cells changed with time in primed mice, the original ratio of each population in the donor, at any stage after priming, was maintained when cultured in recipients for at least 4 weeks. This indicates that conversion from γG_1- to γG_2-memory cells does not occur. (BBB)

2592 INTERACTION BETWEEN GENETICALLY DIFFERENT SOMATIC (LYMPHOID) CELLS TRANSPLANTED IN LETHALLY IRRADIATED RECIPIENTS. Petrov, R. V.; Man'ko, V. M.; Panteleev, E. I.; Seslavina, L. S. (Inst. of Biophysics, Moscow). Tsitologiya, 11: 1149-61(Sept. 1969). (In Russian).

Transplantation of a mixture of cell suspensions of hemopoetic or lymphoid tissues of two different parental genotypes into lethally irradiated mouse recipients $(CBAxC57BL)F_1$ resulted in inactivation of colony-forming activity of the transplant that was detected by the Till and McCulloch method in the recipient spleens graft. This phenomenon is observed after transfer of spleen or bone marrow cell mixtures from animals of two different genotypes, or after transplantation of mixture of lymph node cells of one genotype with spleen or bone marrow cells of the other genotype. The maximal inactivation occurred when lymph node cells served as one of the components of the mixture. Inactivation was manifested also when a mixture of cell suspensions obtained from mice of other genotypes was employed: A + C57BL, A + CBA, C3H + C57BL, and CBA + (CBAxC57BL)F. In vitro incubation of cell suspension during as long as from 2.5 min to 1 hr at 0°C or 37°C failed to effect significantly the inactivation phenomenon. The use of nonsyngeneic kidney cells, microbial antigen, or irradiation-inactivated lymphoid cells as one of the mixture components has shown that inactivation of genetically foreign stem cells required participation of viable lymphoid cells. The inactivation phenomenon can also be detected by the Jerne method. The latter indicates that not only colony-forming cells but also immunocompetent precursors of antibody producers can undergo inactivation. (auth)

Ecology

Refer also to abstracts 2257, 2301, 2318, 2648, and 2649.

2593 (AEC-tr-6880) TRANSACTIONS OF THE 6th CONFERENCE ON THE BIOLOGY OF INLAND WATERS, (10-19 JUNE 1957). Akatova, N. A.; Pavlovskii, E. N.; Shtegman, B. K. (eds.). Translation of Trudy VI Soveshchaniya po Probleman Biologii Vnutrennykh vod (10-19 Iyunya 1957 g.), Izdatel'stvo Akademii Nauk SSSR, Moscow-Leningrad, 1959. 734p. (TT-68-50492; IPST-Cat.-5136; CONF-570601). Dep. CFSTI.

A study on inorganic fertilization of ponds using ^{45}Ca is reported in one paper of the conference; a similar study using ^{32}P is reported in another paper. Approximately 90 additional papers are included on hydrobiology of ponds, lakes, rivers, reservoirs, and basins of the Black Sea and Sea of Azov. (H.L.W.)

2594 (BMI-171-24) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDIES: ATLANTIC-PACIFIC INTEROCEANIC CANAL. FINAL REPORT, TERRESTRIAL ECOLOGY. Golley, Frank B.; McGinnis, John T.; Clements, Richard G. (Georgia Univ., Athens. Inst. of Ecology). May 29, 1969. Contract AT(26-1)-171. 83p. Dep. CFSTI.

For Battelle Memorial Inst., Columbus, Ohio.

In 1966, the University of Georgia, Institute of Ecology, contracted with Battelle Memorial Institute, Columbus, Ohio, to carry out studies in terrestrial ecology in Panama and Colombia. These were part of the bioenvironmental and radiological-safety feasibility studies for an Atlantic-Pacific interoceanic canal authorized under Public Law 88-609, 88th Congress. One objective of the overall study was to determine the best route for, and the feasibility of, constructing a sea-level canal between the Atlantic and Pacific Oceans by nuclear excavation. The objective of the University of Georgia, Terrestrial Ecology program, was to determine the movements of potential radionuclides produced by construction in the terrestrial ecosystems adjacent to the proposed canal routes. Analysis of the movement of radioisotopes through terrestrial ecosystems required information on the concentration and cycling of elements. Since radioactive tracers could not be used and present fallout levels in the ecosystems of interest were very low, it was necessary to follow the cycle of nonradioactive elements. The determination of stable-element cycling in the terrestrial ecosystems required information on the kinds of ecosystems, their biomass, and mineral standing crops. The ecosystems were conceived as a series of compartments: overstory leaves, overstory stems, understory leaves, understory stems, fruits and flowers, epiphytes, litter, roots, soil, herbivores, carnivores, and detritivores. Each compartment was visualized as having a capacity and inputs and outputs. The capacity was defined as the quantity of biomass and/or element contained within the compartment; transfer functions were calculated from the input and output rates. Sixty-three tables are presented to show results. (auth)

2595 (BMI-171-28) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDIES: ATLANTIC-PACIFIC INTEROCEANIC CANAL. SYMPOSIUM ON SEA-LEVEL CANAL BIOENVIRONMENTAL STUDIES. Martin, William E. (ed.) (Battelle Memorial Inst., Columbus, Ohio). Apr. 21, 1969. Contract AT(26-1)-171. 189p. (CONF-680945-1). Dep. CFSTI.

From 19th Annual Meeting of the American Institute of Biological Sciences, Columbus, Ohio.

Twenty papers are included in the symposium on bioenvironmental studies for judging the radiological safety feasibility of nuclear excavation plans for the construction of a sea-level canal across the isthmian region of Central America. Extensive field studies of human, agricultural, terrestrial, fresh-water, and marine ecology were made in eastern Panama and northwestern Colombia; these studies were part of the program to predict potential exposure and internal radiation doses to human populations living in the vicinity of the proposed canal routes. Predictions of radionuclide production and initial fallout distribution were used to develop an ecological model of radionuclide transfer through food chains and other environmental pathways leading to man. A study on uptake and translocation of ^{134}Cs, ^{59}Fe, ^{85}Sr, and ^{185}W by banana plants and a coconut plant following foliar application demonstrated the feasibility of conducting environmental tracer experiments. Studies on retention of ^{45}Ca, ^{137}Cs, ^{86}Rb, and ^{85}Sr from dilute solutions by Panamanian clays indicated that all clays used had an uptake capacity of practically 100% of the applied radionuclides. (H.L.W.)

2596 (GAT-605) ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS, FIRST HALF 1969. Kalmon, B.; Hulett, S. H. (Goodyear Atomic Corp., Piketon, Ohio). Aug. 27, 1969. Contract AT(33-2)-1. 11p. Dep. CFSTI.

The average environmental radiation and concentration levels for the Goodyear Atomic Corporation gaseous diffusion plant, for the first half of 1969, are summarized in this report. The results for the first and second half of the calendar year 1968 were previously reported by GAT-575 but are also included in tabulated form in this report. For the first half of 1969, the water α and water β-γ decreased over the calendar year 1968 values. The air α and air β-γ values remained the same. Penetrating background dose rates for the first half of 1969 were considerably lower when compared with the calendar year 1968 values. In the calculations, all of the exposure rates were assumed attributable to plant operations. As in the past, however, the off-site and on-site patterns are very much alike in form and intensity with no significant dif-

ference between average values. Based on the on-site and off-site intensities, it is evident that the plant operations have not added appreciably to the general background penetrating radiation. (auth)

2597 (NYO-4039-1, pp 33-5) PREDICTION EQUATIONS FOR ^{90}Sr IN THE HUMAN POPULATION. Comar, C. L.; Talisayon, S. D.; Bubar, R. H. (New York State Veterinary Coll., Ithaca).

Two types of prediction equations are available in the literature that relate the ^{90}Sr burden of a population at a given time to that existing at a previous time and the ^{90}Sr level in the diet during the two time periods. One is based on a simple ^{90}Sr balance, the other is based on a $^{90}Sr/Ca$ balance. Both take into account the turnover of ^{90}Sr in the skeleton; neither take into account the reutilization of ^{90}Sr liberated from bone. More detailed equations were developed that are based on balances, Sr-Ca discrimination, ^{90}Sr turnover, and reutilization. The validity of the model is being determined by studies with growing pigs using both enriched stable strontium diets and double tracer experiments with radioactive strontium and calcium. (auth)

2598 (NYO-4039-1, pp 36-8) VALIDATION IN SWINE OF PREDICTION EQUATIONS FOR ^{90}Sr IN THE HUMAN POPULATION. Comar, C. L.; Bubar, R. H.; Talisayon, S. D. (New York State Veterinary Coll., Ithaca).

Various forms of the Comar equations described in the preceding report are being studied on the basis of observations in growing pigs using diets enriched with stable Sr as well as double tracer experiments. Direct observations are made or values known for all the variables except f, the fractional rate of removal of calcium or strontium. The reliability of the model as well as the relations among the Loutit and Rivera formulations should come out of this study as soon as all the data are in. It is also intended to utilize the human data as compiled by Rivera to check the fit obtainable. (auth)

2599 (NYO-4039-1, pp 113-20) DATA APPRAISAL AND EVALUATION OF RADIOACTIVE FALLOUT IN FOODS. Thompson, J. C. Jr.; Comar, C. L. (New York State Veterinary Coll., Ithaca).

Results on radioactivity from all major national and international reporting agencies are being consolidated for use in extensive evaluations of the nature and extent of radioactive fallout in the atmosphere. Data were coded and machine punched for use in comparative studies and reports. More than 25,000 cards will be included in this compilation. These data form a basic and integral part of many other studies concerned with environmental radiation. Excerpts from one of the more recent manuscripts from this department illustrate such usefulness. (auth)

2600 DATA, SECTION I, MILK AND FOOD. Radiol. Health Data Rep., 10: 347-57(April 1969).

The concentrations of ^{90}Sr, ^{131}I, and ^{137}Cs in milk samples collected during May 1968 through April 1969 by the Canadian, United States, and Central and South American Milk Sampling Networks are presented. All data are presented in tabular form and are discussed in the article in terms of the Radiation Protection Guide and Protective Action Guides as defined by the Federal Radiation Council. (E.R.B.)

2601 ENVIRONMENTAL DISTURBANCES DUE TO RADIATION FALL-OUT. Takisawa, Y. Naika, 21: 859-63(May 1968). (In Japanese).

Radiation from fallout presents a threat to human life not only through immediate effects but also through possible long range genetic effects. The radioecology of different radionuclides is fast becoming an important subject that needs to be pursued to allow better understanding of the possible ways by which contamination can take place. The fallout of short lived nuclides over Japan can be correlated with the many nuclear bomb tests that have been carried out in the past. The fallout varies according to locality with the rainfall, and there is a trend to higher fallout the higher the rainfall. Thus, northern Japan and the areas bordering the Japan Sea receive the highest fallout. Also the fallout is heaviest during the rainy months. The pattern of pickup of radionuclides through food in Japan differs from that of the western world because of the difference in diets. The takeup of ^{90}Sr is relatively low because milk consumption is rather small. On the other hand, there is relatively large uptake through leafy and root vegetables. The iodine uptake picture is clouded by the rather large normal iodine uptake of the Japanese such that there is possibly an isotope dilution effect. It is concluded that there is as yet little evidence of pronounced effects of fallout on the Japanese as yet; however, there is no way to assess any genetic effects. (TTT)

2602 DATA, SECTION I, MILK AND FOOD. Radiol. Health Data Rep., 10: 381-91(Sept. 1969).

The function of the various milk sampling networks, the criteria used in the development of a common reporting basis, and the Federal Radiation Council guide lines applicable to milk surveillance activities are discussed. Data are presented on the concentrations of ^{90}Sr, ^{131}I, and ^{137}Cs in milk samples from Canada, United States, and Central and South America during June 1968 to May 1969. Federal and State agencies are engaged in continuing surveillance of the radionuclide levels in foods and in the diets of various institutes and age groups to be used in estimating the dietary intake of radionuclides in the United States on a continuing basis. No data are reported from these agencies in this issue. (E.R.B.)

2603 DATA, SECTION II, WATER. Radiol. Health Data Rep., 10: 393-8(Sept. 1969).

The average gross α and β radioactivity in raw surface waters from selected nationwide sampling sites are given for February 1969. The radioactivity levels at each station (given as pCi/liter) are separated into values for suspended and dissolved materials. The gross β radioactivity in raw surface waters of New York State are presented from selected sampling sites for July to December 1968. The content of ^{90}Sr and tritium in surface waters of New York State are also given for the same period. All of the New York State data are given in tabular form and are separated into maximum, minimum, and average values (pCi/liter) for each sampling site. (E.R.B.)

2604 DATA, SECTION III, AIR AND DEPOSITION. Radiol. Health Data Rep., 10: 399-404(Sept. 1969).

Data on the radioactivity in airborne particulates and precipitation are presented from the Radiation Alert Network (USA), Canadian Air and Precipitation Monitoring Program, and Pan American Air Sampling Program. The Radiation Alert Network reports the gross β radioactivity in surface air samples (pCi/m^3) and in precipitation as total deposition (nCi/m^2). The Canadian Air and Precipitation Monitoring Program reports the gross β radioactivity in surface air samples (pCi/m^3) and in precipitation as average concentration (pCi/liter) and total deposition (nCi/m^2). The Pan American Air Sampling Program reports the gross β radioactivity in surface air samples (pCi/m^3). All data are presented in tabular form and represent the sampling activity of the networks for May 1969. (E.R.B.)

2605 DATA, SECTION IV, OTHER DATA. Radiol. Health Data Rep., 10: 405-17(Sept. 1969).

The ^{90}Sr content of human bone samples in the United States is given for July to September 1968. The data are categorized according to geographic location of the sample, bone type, age, sex, ^{90}Sr content (pCi/kg bone), Ca content (g/kg bone), and $^{90}Sr/Ca$ ratio (pCi/g). The environmental levels of radioactivity at Atomic Energy Commission installations are presented. These include a detailed breakdown of the radioactivity from various sources in the environs of the Hanford Atomic Products Operation at Richland, Washington, for the calendar year 1967 and the results of air and precipitation monitoring in the environs of the Los Alamos Scientific Laboratory at Los Alamos, New Mexico, for the calendar year 1968. The U. S. Atomic Energy Commission announced the detonation of two underground nuclear tests at the Nevada Test Site during August 1969. (E.R.B.)

2606 ^{239}Pu IN HUMAN TISSUES AND BONE. Magno, Paul J.; Kauffman, Peter E.; Groulx, Paul R. (Northeastern Radiological Health Lab., Winchester, Mass.). Radiol. Health Data Rep.; 10: 47-50(Feb 1969).

An average concentration of 7×10^{-11} μCi $^{239}Pu/g$ was found in human bone samples ranging in age from 2 to 24 yr. This concentration results in an average dose equivalent rate to bone of about 0.3×10^{-4} rem/year. An average concentration of 7×10^{-10} μCi $^{239}Pu/g$ found in liver samples from older adults results in an average dose equivalent rate of about 7×10^{-4} rem/year. These figures were compared to the Federal Radiation Council's Radiation Protection Guides and the dose limits recommended by the National Council on Radiation Protection and Measurements and the International Commission on Radiological Protection. From the data in this report, it was concluded that the concentrations of ^{239}Pu in body tissue result in average equivalent dose rates well below the suggested radiation protection guides and dose limits. (auth)

2607 DATA ON MILK AND FOOD. Radiol. Health Data Rep., 10: 51-61(Feb. 1969).

The concentrations of ^{90}Sr, ^{131}I, and ^{137}Cs in milk samples are given for November 1967 through October 1968. The samples were collected by the Canadian Milk Network, Pan American Milk Sampling Program, and Pasteurized Milk Network (USA) at selected sampling sites. All data are presented in tabular form and are

discussed in the article in terms of the Radiation Protection Guides and Protective Action Guides as defined by the Federal Radiation Council. (E.R.B.)

2608 DATA ON WATER. Radiol. Health Data Rep., 10: 62-9(Feb. 1969).

The gross α and β radioactivity in surface waters from selected sites in the United States are presented for August 1968. Similar data are presented as monthly averages during 1967 for United States Coast Guard water supplies and for surface waters and water supplies in Florida. A comparison of the gross α and β radioactivity in raw and treated municipal water supplies in Minnesota during January to June 1968 is also presented. All data are presented in tabular form. (E.R.B.)

2609 DATA ON AIR AND DEPOSITION. Radiol. Health Data Rep., 10: 70-6(Feb. 1969).

Data on the radioactivity of airborne particulates and precipitation are presented. The monitoring networks reporting sampling data include: Radiation Alert Network (USA)—gross β radioactivity in surface air during October 1968; Canadian Air and Precipitation Monitoring Program—gross β radioactivity in surface air and precipitation during October 1968; Mexican Air Monitoring Program—gross β radioactivity of airborne particulates during June 1968; and Pan American Air Sampling Program—gross β radioactivity in surface air during October 1968. All sampling data are presented in tabular form and are separated into maximum, minimum, and average values for the month reported. (E.R.B.)

2610 OTHER DATA. Radiol. Health Data Rep., 10: 77-88 (Feb. 1969).

The ^{131}I content of bovine thyroid is reported for samples from selected states collected during July to September 1968. The data are given in pCi/g of thyroid tissue and are separated into maximum, minimum, and average values. The ^{90}Sr content of human bones is reported for samples collected in the United States during October to December 1967. The data are categorized by geographical location, type of bone, age of person sampled, and sex, and are reported as pCi^{90}Sr/kg bone, gCa/kg bone, and ^{90}Sr/Ca ratio (pCi/g). Environmental levels of radioactivity are reported for January to December 1967 at Knolls Atomic Power Laboratory in Schenectady, New York, and Shippingport Atomic Power Station in Pennsylvania. The United States Atomic Energy Commission announces the detonation of three underground nuclear tests at the Nevada Test Site during January 1969. (E.R.B.)

2611 ACCUMULATION OF RADIOACTIVITY IN RICE FIELDS. Katsurayama, Kosuke. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 293-7(Oct. 1968). (In French).

The adsorption capacity of the following radioactive isotopes in the soil is discussed: Li, Na, K, Rb, Mg, Cs, Ca, Co, Ba, Sr, H, La, and Th. Equations are given for coefficients of distribution and exchange. Ion exchange capacity of the soil is discussed. Estimation of radioactive concentration in the root zone of rice fields is based on the following phenomena: introduction of water into the rice field; percolation in the superficial soil of the rice field; disintegration of radioactive elements; and accumulation of radioactivity in cultivable soil. A method for estimating the quantity of radioactivity carried by irrigation water into the rice field in the course of a year is described. (H.L.W.)

2612 TRITIUM IN NEW YORK STATE WATERS, 1965. Anderson, Kurt (New York State Dept. of Health, Albany). Radiol. Health Data Rep., 10: 93-7(Mar. 1969).

The tritium content of the natural and surface waters of New York State was determined. The data, which were collected from selected sampling locations, are presented in the form of three tables. In the first table, data are presented on samples collected throughout the state during 1965. In the second table, covering the same period of time, the samples were limited to the vicinity of the Nuclear Fuels Services reprocessing plant. The third table contains data on the tritium content of Long Island well water during July 1965. Sampling locations and well depths are included. (E.R.B.)

2613 SURVEILLANCE FOR ^{85}Kr IN THE ATMOSPHERE. Sax, N. Irving (New York State Dept. of Health, Albany); Reeves, Robert R.; Denny, J. David Radiol. Health Data Rep., 10: 99-101(Mar. 1969).

A practical technique for conducting routine surveillance for atmospheric ^{85}Kr was developed. Following an explanation of the procedure, data are presented on the ^{85}Kr content of the atmosphere in New York State during April 1967 to March 1968. The majority of the ^{85}Kr in the atmosphere sampled was directly related to fuel element reprocessing activities. (E.R.B.)

2614 DATA ON MILK AND FOOD. Radiol. Health Data Rep., 10: 103-13(Mar. 1969).

Data are presented, in tabular form, on the ^{90}Sr, ^{131}I, and ^{137}Cs content of milk in the United States, Canada, and Central and South America. The sampling locations are given, the type of sample (pasteurized or raw milk), and the average concentration of the radionuclides (nCi/liter) for November 1968 and for December 1967 to November 1968. Data are also given on the ^{89}Sr and ^{140}Ba content of selected milk samples from the Pasteurized Milk Network in the United States and Canal Zone for November 1968. (E.R.B.)

2615 DATA ON WATER. Radiol. Health Data Rep., 10: 115-17(Mar. 1969).

The radioactivity in surface waters of the United States is given for September 1968. The data, which are presented in tabular form, include sampling locations and average gross α and β radioactivity (pCi/liter) in suspended and dissolved materials in raw surface water samples. (E.R.B.)

2616 DATA ON AIR AND DEPOSITION. Radiol. Health Data Rep., 10: 119-24(Mar. 1969).

The radioactivity in airborne particulates and precipitation is reported for samples collected during November 1968 by the Radiation Alert Network, Canadian Air and Precipitation Monitoring Program, and Pan American Air Sampling Program. The data include: the gross β radioactivity (pCi/m^3) in surface air samples in Canada, United States, and Pan America; and the gross β radioactivity in precipitation (nCi/m^2-total deposition) in the United States. (E.R.B.)

2617 OTHER DATA. Radiol. Health Data Rep., 10: 125-33(Mar. 1969).

An offsite surveillance program was conducted for the U. S. Atomic Energy Commission (USAEC) by the Bureau of Radiological Health (Southwestern Laboratory) for three events at the Nevada Test Site during January and March 1968. The data from the off site monitoring activity, presented in tabular form, include the gross β radioactivity and the concentrations of ^{131}I, ^{132}I–Te, ^{133}I, and ^{135}I in air and milk samples from selected locations around the test site. Analysis of the data revealed that the low levels of radioactivity released to the environment by these events did not exceed the safety criteria established by the USAEC. Data on the environmental levels of radioactivity at Atomic Energy Commission Installations include results of environmental monitoring at Bettis Atomic Power Laboratory in Pittsburgh, Pa., and at the S1C Prototype Reactor Facility in Windsor, Conn. The data represent the results of monitoring activities during 1967 at both installations. The USAEC announces the detonation of one low yield underground nuclear test at the Nevada Test Site during February 1969. (E.R.B.)

Genetics and Cytogenetics

Refer also to abstracts 2592, 2714, and 2829.

2618 SENSITIVITY OF BONE-MARROW CELLS OF MONKEYS TO THE LONG-TERM DAILY IRRADIATION WITH X RAYS AT SMALL DOSES. Kosichenko, L. P.; Dzhikidze, E. K. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Genetika, 5: No. 6, 160-4(June 1969). (In Russian).

The principles governing the cytogenetic changes in the bone marrow cells of monkeys Macaca mulatta induced by daily irradiation with x rays at small doses (1 to 4 R) for a long period were studied. The total doses received by the animals during the entire period of irradiation were 130 R, 420 R, 1255 R, 1701 R, and 2767 R. It was established, that the long-term repeated irradiation at small doses resulted in the damage of the hereditary structures in the cells of the blood-forming tissue. The individual variations in the susceptibility of bone marrow cells are leveled down with the increasing total dose. The main type of structural damages of chromosomes are acentric fragments. The process of fusion of the centric fragments was markedly suppressed. The frequency of chromosomal aberrations increased with the increasing total irradiation dose. However the increase of the aberration frequency was not proportional to the increase of the total dose, but lags conspicuously behind the latter, which is explained by the increasing proliferative activity of the tissue. (auth)

2619 LETHAL AND MUTAGENIC EFFECTS OF 1-METHYL-3-NITRO-1-NITROSOGUANIDINE AND UV ON THE CULTURE OF THE NOVOBIOCIN-PRODUCING STRAIN OF ACTINOMYCES SPHEROIDES. Klepikova, F. S. (Research Inst. of Antibiotics, Moscow). Genetika, 5: No. 6, 154-9(June 1969). (In Russian).

A comparative study was made of the lethal and the mutagenic

effect of I-methyl-3-nitro-I-nitrosoguanidine (NG) and of uv rays, as well as of the combined effect of both factors on Actinomyces spheroides strain 215 producing novobiocin. The efficiency of NG depends on the concentration of the mutagen and on the duration of treatment. The optimal effect for morphological mutations was observed at a concentration of 0.5 mg/ml and 22 hr of exposure. An equal frequency of mutations in cases of treatment with uv rays and with NG is observed at different rates of survival, i.e., about 0.001% and 1.0% respectively. The advantage of NG with respect to the frequency of plus variants in the production of the antibiotic was observed; uv rays extend the range of variation mainly in the direction of minus variants. In the case of the combined treatment with both mutagenic agents in the sequence NG → uv rays, a protective effect of NG against uv rays was observed. The treatment with NG eliminated the effect of the subsequent treatment with uv rays almost entirely as far as survival and mutations are concerned. (auth)

2620 A STUDY ON THE RELATIONSHIP BETWEEN THE CAPACITY OF GENE RECOMBINATION AND THE RADIOSENSITIVITY IN ESCHERICHIA COLI K-12. Fradkin, G. E.; Rabinkova, E. V.; Torosyan, M. V.; Fil'kova, E. V. (Inst. of Biophysics, Moscow). Genetika, 5: No. 6, 147-53(June 1969). (In Russian).

The correlation between the capacity of gene recombination and the radiosensitivity of cells in Escherichia coli K-12 was studied. The rec⁻ strains studied, viz. AB 2462, AB 2463, and AB 2462 thy⁻ NO. 8, that are the derivatives of the strain AB 1157 rec⁺, were characterized by a high sensitivity to γ radiation and a very poor capacity of the formation of recombinations in the corresponding crosses. The thymine-dependent mutant derived from the initial rec⁻ strain AB 2462 was characterized by the absence of the phenomenon of the classical thymineless death. The increase of the frequency of recombinations in the intermediate rec⁻ strains was concurrent with the increase of radioresistance of cells and of the thymineless death-rate in the thymine-requiring mutant AB 2462 thy⁻ NO. 8. (auth)

2621 BEAN MUTANT INDUCED BY IONIZING RADIATION. III. WRINKLED LEAF. Moh, Carl C. (Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica). Contract AT (30-1)-2043. Turrialba, 18: 181-2(Apr.-June 1968).

An experiment was designed for investigating the mutation frequency induced by chronic irradiation in the common bean (Phaseolus vulgaris L.). Plants of a bean variety, Mexico 80-R, were grown concentrically around a ^{137}Cs source gamma field and were exposed to various levels of radiation dose from 25 tp 100 R for the whole life cycle. A daily dose of 75 R was found to be the maximum at which a bean plant could produce seeds. At maturity, seeds from each irradiated plant were harvested and the mutation studies were carried out in the R_2 and the R_3 using a selfed progeny test. A wrinkled leaf mutant was isolated from the R_3 progenies whose R_1 parents were exposed to a daily chronic γ dose of 75 R for 80 days. The heterozygotes of this mutant line were then propagated in the next several generations and the genetic results were obtained in the R_8 selfed progeny test. Genetic study indicated that the wrinkled leaf mutant is a recessive character with single gene control. This proportion did not deviate from the ratio of 1 normal : 2 heterozygotes : 1 recessive. (C.H.)

2622 INTERMEDIATE NEUTRONS (0.2 MeV) AS MUTAGENS FOR SELECTION OF PRODUCERS OF CHLORTETRACYCLINE. Fyalkouski, S. M.; Troitski, N. A. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk, No. 5, 107-10(1968). (In Russian).

Natural and radioinduced variability in the production of chlortetracycline was studied using intermediate neutrons, γ rays, and slow protons. It was established that intermediate neutrons were twice as effective as γ rays and six times as effective as slow protons in relation to the yield of plus-variants of Streptomyces aureofaciens. It was supposed that the high genetic effect of intermediate neutrons was related to the induction of chromosome transformations. (tr-auth)

2623 INVESTIGATIONS OF THE IMMUNOCHEMICAL PROPERTIES OF A COAGULASE-NEGATIVE MUTANT OF STAPHYLOCOCCUS AUREUS. Jungerman, D.; Lipnicki, D. (School of Medicine, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Biol., 17: 101-7(1969).

The chemical and serological properties of a coagulase-negative mutant obtained by uv irradiation of a Staphylococcus aureus strain are reported. Four strains (Cown's type I, II and III, and type 15 Pillet) were subjected to uv radiation. A Westinghouse bactericidal type G30T8 lamp (emission 95% at a wavelength of 2537 Å) was used. Among the four strains studied, a coagulase-negative mutant could be obtained only from strains belonging to type I after 3-min uv irradiation. The descendant colonies of the mutant did not revert to the parent forms even after several passages. (BBB)

2624 THE EFFECT OF LOCAL GAMMA IRRADIATION ON THE NUMBER OF CHROMOSOMAL ABERRATIONS IN LYMPHOCYTES OF THE PERIPHERAL BLOOD OF MAN. Berlin, L. B. Dokl. Akad. Nauk SSSR, 187: 446-8(July 11, 1969). (In Russian).

Tumor patients after extirpation of the womb were given a γ radiation dose of 500 R each day. After session 1, 3, 5 to 6, 10 to 11 and 16 to 17, venal blood samples were taken, and leukocytes were cultivated to study metaphase chromosomes of the first mitosis. The number of chromosomal aberrations was almost a linear function of the local dose. With increasing radiation dose, not only does the total number of chromosomal breaks increase, but the number of aberrant cells with two, three, or more breaks increases also. The number of breaks per cell per 1 R dose doubles on increasing the dose from 50 to 400 R with a whole-body radiation, but this index decreases with increasing dose on giving a fractionated dose, since the more radiation-resistant leukocytes are irradiated in the later sessions. (TTT)

2625 GENETIC CONTROL OF PHENYLALANINE AND TYROSINE BIOSYNTHESIS IN NEUROSPORA CRASSA. El-Eryani, A. A. (Yale Univ., New Haven). Contract AT(30-1)3098. Genetics, 62: 711-23(Aug. 1969).

Genetic and biochemical investigations of phenylalanine-requiring and/or tyrosine-requiring mutants of Neurospora crassa have revealed that at least three genetic loci are concerned with the biosynthesis from chorismic acid of the keto acids of these two aromatic amino acids. The following conclusions concerning these three loci have been established: mutants at the pt locus lack activity for the enzyme chorismic mutase which converts chorismic acid to prephenic acid; tyr-1 mutants lack activity for prephenic dehydrogenase, the enzyme which catalyzes the conversion of prephenic acid to 4-OH-phenylpyruvic acid; phen-2 mutants lack activity (or in the case of the allele previously designated phen-3 have reduced and unstable activity) for the enzyme prephenic dehydratase which transforms prephenic acid to phenylpyruvic acid. The two loci tyr-1 and phen-2 are closely adjacent in linkage group IIIR. Unlike the situation in E. coli and A. aerogenes, in N. crassa these three post-chorismic acid enzymes are not aggregated. They are separable by sucrose density-gradient centrifugation and by Sephadex gel filtration. The activities of prephenic dehydrogenase and prephenic dehydratase are regulated by their end products, tyrosine and phenylalanine, respectively. On the basis of comparisons with wild type, the one available tyr-2 mutant possesses a prephenic dehydrogenase with relatively low activity. The strains phen-1 and NM-160 (tyr) have essentially wild-type levels of chorismic mutase, prephenic dehydrogenase and prephenic dehydratase. The reasons for the particular requirements exhibited by these two strains have not yet been clarified. (auth)

2626 EFFECT OF RADIATION ON COMPETITIVE ABILITY IN DROSOPHILA MELANOGASTER. Weisbrot, David R. (Tufts Univ., Medford, Mass.). Genetics, 62: 819-25(Aug. 1969).

Induced genetic changes increase the array of metabolic end-products produced by a population. Thus, in a particular strain of Drosophila these products may modify the medium upon which the flies are growing, thereby affecting the fitness of competitors. For example, the substances added to the medium may supplement the nutritional requirements of the competitors, thus facilitating their survival, or such substances may act antagonistically, thus impairing the viability of the competitors. Therefore, competition among irradiated genotypes, when compared with their unirradiated sibs, may lead to different survival rates due both to the direct effects of the radiation on the carriers of the induced mutations, as well as indirect effects such as the interactions among competing genotypes. The present experiment indicates that irradiation modifies the competitive ability of particular strains of Drosophila. While the direct effect as determined by comparisons of larval survival of noncompeting, irradiated and unirradiated sibs has little or no influence on fitness four generations after radiation treatment, the indirect effect as determined by comparisons of larval survival of irradiated and unirradiated sibs under competitive conditions is a significant improvement in fitness in some of the irradiated lines. The implications of these experiments are: that measurements on the genetic effects of radiation must consider the interactions among the segregating genotypes which may enhance or obscure the direct effects; that polymorphism may be maintained by facilitation among competitors as well as by establishment of separate biotic niches by the competitors within a physically uniform environment; and finally, that diversity, even at the sub-specific level, may be self-maintaining as the more diverse a population, the more likely that extreme genotypes may be supported by the biotically induced modifications of the environment. (auth)

2627 REPAIR TIME OF CHROMOSOME BREAKS INDUCED BY PULSED X-RAYS OF ULTRA-HIGH DOSE-RATE. Prempree, T.; Michelsen, A.; Merz, T. (Johns Hopkins Univ., Baltimore). Int. J. Radiat. Biol., 15: 571-4(1969).

Cultured human lymphocytes were treated with conventional x rays at a dose rate of 100 R/min and with pulsed x rays at a dose rate of 2.7×10^{12} R/min. Dicentric chromosomes were used as an index for completed repair. A range of fixation times was used in all treatment groups to ensure that the peak aberration frequencies were obtained. It was found that the repair time of chromosome breaks in G_1 cells with conventional x ray was 90 min or less, but longer than 60 min; the repair time of chromosome breaks induced by pulsed x rays of high dose rate was the same as that for conventional x rays. Although the results of the repair time study of the two dose rates were the same, the frequencies of dicentrics for 200 R of conventional x ray was 15%, while that for the same dose of pulsed x rays was only 10%. (H.L.W.)

2628 DIFFERENT MODES OF LOSS OF PHOTOREVERSIBILITY OF MUTATION AND LETHAL DAMAGE IN ULTRAVIOLET-LIGHT RESISTANT AND SENSITIVE BACTERIA. Nishioka, H.; Doudney, C. O. (Albert Einstein Medical Center, Philadelphia). Contract AT(30-1)-3893. Mutat. Res., 8: 215-28(Sept.-Oct. 1969).

Loss of photoreversibility of uv-radioinduced mutations to streptomycin resistance and lethal damage in an hcr^+ strain of Escherichia coli occurs during the first 20 min of postirradiation incubation and is unaffected by absence of tryptophan with an amino acid-requiring substrain or by absence of thymine with a thymine-requiring substrain, but is blocked by dinitrophenol. The initial postirradiation replication of DNA that begins after 40 min of incubation is significant in the mutation process since expression of streptomycin resistance (measured in streptomycin-containing agar medium blocking protein synthesis) does not occur unless DNA replication is allowed before plating and is thymine-dependent. Loss of photoreversibility of streptomycin-resistant mutations and lethal damage in an hcr^- strain of E. coli begins after 20 min of incubation and requires 80 min for completion and is tryptophan-dependent and thymine-dependent. Unlike streptomycin-resistant mutation, loss of photoreversibility of suppressor mutations in a tryptophan-requiring strain is correlated with DNA replication even in hcr^+ bacteria and is amino acid- and thymine-dependent in hcr^- bacteria. (auth)

2629 EFFECTS OF LIQUID HOLDING ON THE INDUCTION OF MUTATIONS IN AN ULTRAVIOLET-SENSITIVE STRAIN OF ASPERGILLUS NIDULANS. Wohlrab, Gisela; Tuveson, R. W. (Univ. of Illinois, Urbana). Mutat. Res., 8: 265-75(Sept.-Oct. 1969).

It was shown that a mutation to uv-radiosensitive (uvs-I) had the effect of reducing the yield of adenine-independent mutations in Aspergillus nidulans whether the comparison was made on the basis of dose or survival. Methionine-independent mutants were induced with a greater frequency only at higher doses of uv and lower levels of survival. When the uvs-I strain was held at 25°C in buffer following uv treatment, survival increased to a maximum at between 48 and 96 hr. The level of survival attained by the uv-sensitive mutant during liquid holding was equivalent to that observed with a uvs^+ strain plated immediately following uv treatment or after 96 hr of liquid holding. The uvs-I mutation allowed for the expression of liquid-holding repair of uv damage in A. nidulans. The yield of both adenine- or methionine-independent mutants based on survival increased during liquid holding of the uvs-I strain to a level greater than that observed in an equivalent uvs^+ strain. The yield of adenine- or methionine-independent mutants in the uvs^+ strain was not altered significantly during liquid holding. We interpret the uvs-I mutants of A. nidulans to represent a regulatory mutation in a function concerned with the repair of radiation damage that in addition to affecting the rate of repair leads to reduced fidelity of repair. (auth)

2630 DESYNAPSIS AND CHROMOSOME BREAKS IN A MUTANT OF PISUM SATIVUM. Klein, Hans-Dieter (Univ., Bonn). Mutat. Res., 8: 277-84(Sept.-Oct. 1969). (In German).

An x-radioinduced mutant of Pisum sativum showed considerable meiotic irregularities caused by a reduction of chiasma frequency and the occurrence of chromosome breakage during the first meiotic prophase. In the subsequent staged univalents, fragments, and bridges arise, resulting in abnormal chromosome distribution and complete sterility of the mutant. The simultaneous occurrence of reduced chiasma frequency and chromosome breakage seems suitable to test the hypothesis of Lewis and John that chromosome breakage might be produced by errors in the crossover process. The following results are regarded as a confirmation of this assumption. Both chromosome breakage and reduced chiasma frequency take place in meiotic prophase during the four-strand stage. In both cases, two of the four chromatids are involved in the exchange process, and in both cases the exchange is complete and reciprocal. The investigation of anthers being fixed at two different developmental stages of ontogenesis—immediately after entering flowering period and 4 weeks later—reveals remarkable differences as far as the amount of reduced chiasma frequency and aberration frequency is concerned. Both these factors change in the same way: the greater the number of chiasmata, the higher the number of aberrations, and vice versa. A comparison between fragment size at metaphase I and chiasma distribution in the bivalents shows that chromosome breakage and chiasma formation are located in the same chromosome regions. Because of the predominance of sister-chromatid reunions, the possibility is discussed that ineffective chromosome pairing might be responsible for both the reduced chiasma frequency and the occurrence of fragments and bridges. (auth)

2631 FREQUENCY OF X-RAY-INDUCED CROSSING-OVER IN STRUCTURALLY DIFFERENT TYPES OF CHROMOSOME OF DROSOPHILA MELANOGASTER FEMALES. Puro, Jaakko (Univ. of Turku, Finland). Mutat. Res., 8: 303-16(Sept.-Oct. 1969).

In order to test the influence of the proximal heterochromatin upon the induction of recombination in an adjacent euchromatic region, crossing-over experiments were carried out simultaneously with two types of Drosophila melanogaster female irradiated with x rays ranging in doses from 1 to 6 kR. Females of one of the genotypes (designated N) were heterozygous for a series of 3rd chromosome marker genes, including st, in, and ri, but otherwise had normal chromosomes. Females of another type (designated T) were homozygous for a translocation, T(2:3)spy, and heterozygous for the same three markers. This translocation was used to relocate the markers in respect to the heterochromatin. The frequency of the st–in recombinants in the progeny from eggs laid by the N females 5 to 12 days after irradiation increased proportionally to the dose. The T females also showed an increase in the frequency of crossing-over after irradiation, but the effect was maximal after 3 kR and was then progressively decreased after 4 and 6 kR. When the frequency of exchange attributable to the treatment was calculated on the assumption that the crossing-over induction took place independently of meiotic crossing-over, the effect was the same in the two genotypes at 1 and 3 kR. This indicates that the proximity of the heterochromatin had no influence on the frequency at which an exchange was induced by x-rays in normal chromosomes. Evidence was also found for suggesting that the frequency of induced recombination is a mere function of the number of salivary chromosome bands between gene loci, and hence that there is no hypersensitivity of heterochromatin. The difference between the mode of dose dependence of crossing-over in the two genotypes investigated can be explained on the basis of the hypothesis of Bateman and Chandley that synapsis of chromosomes is disrupted by irradiation that thus interferes with meiotic crossing-over, and that the extent of the disruption, beginning at the distal end, is proportional to dose. (auth)

2632 UV ACTION ON THE GENETIC RECOMBINATION AFTER IRRADIATION OF POLAR CAP CELLS OF DROSOPHILA FEMALES; HETEROZYGOUS FOR MARKERS LOCALIZED ON CHROMOSOME III. Prudhommeau, C.; Proust, J. (Faculte des Sciences, Orsay, France). Mutat. Res., 8: 317-26(Sept.-Oct. 1969). (In French).

In order to irradiate oogenic primordial germ cells with 2537 Å uv light of slight penetrating ability, polar cap cells were exposed. Heterozygous markers on the third chromosome enabled us to measure the crossing-over among progeny from treated cells. Two distinct effects of uv can be observed; one is on mitotic recombination and the other on meiotic recombination. Progenies from three single females having clusters of cross-overs were found. These clusters were related to uv-induced mitotic recombinations during the first division following irradiation time. Mitotic recombinations were induced in the centromeric region. Although some variability exists, crossing-over among descendants from the uv-treated flies was consistently higher than spontaneous crossing-over. These uv-induced meiotic cross-overs were predominantly found in the centromeric region. This effect is photoreactivable. Although premeiotic cells were exposed to the uv light, meiotic cells were affected that may indicate a delay in the time of action. The most likely hypothesis is that uv produces some physiological damage. This disturbing of metabolic activity might be the primary influence on meiotic crossing-over. (auth)

2633 ON THE NATURE OF Y CHROMOSOME FRAGMENTS INDUCED IN DROSOPHILA MELANOGASTER FEMALES. I. IMMATURE OOCYTES. Williamson, John H. (Oak Ridge National Lab., Tenn. Univ. of California, Riverside). Mutat. Res., 8: 327-35(Sept.-Oct. 1969).

Induction of fragments of Y chromosomes in Drosophila melanogaster females carrying a compound-X and a doubly marked Y chromosome depends on association of the Y with some other chromosome or association of the two arms of the Y. About 75% of all Y chromosome fragments recovered in the progeny of x-irradiated females are products of induced interchanges between the Y and the fourth chromosome or between the two arms of the Y. Consideration of the frequencies of interchanges involving the X and Y, the X and the 4, Y and 4, and between the two arms of the Y leads to the suggestion that these chromosomes are associated in a chromocentral-like arrangement in the oocyte nucleus that may correspond to the karyosome of the developing oocyte. (auth)

2634 COMPARISON OF RADIOSENSITIVITY AMONG DIFFERENT SILKWORM STRAINS WITH RESPECT TO THE KILLING EFFECT ON THE EMBRYOS. Murakami, Akio (National Inst. of Genetics, Misima, Japan. Bowling Green State Univ., Ohio). Mutat. Res., 8: 343-52 (Sept.-Oct. 1969).

In a previous paper, marked differences in radiosensitivity to x rays were reported among different silkworm strains with respect to the killing of hibernating embryos. In the relatively sensitive strains, Ascoli and Kojiki have an LD_{50} amounting to one-tenth of the value of the relatively resistant strains, Tenmon and Kansen. It was known, however, that the radiosensitivity of silkworm embryos was markedly different according to the developmental stage of the embryos. The present study was conducted in order to eliminate such variance. By taking advantage of synchronous division of cells, at early cleavage stages of eggs, the sensitivity was compared within one cell cycle for two representative strains, Kansen and Kojiki. As was already reported by the present author, the more sensitive phase to killing effects of x rays in early cleavage cells in the silkworm was the dividing phase, while the more resistant phase was the interphase. The eggs from inbred strains of Kansen were 7 to 8 times as resistant as Kojiki, and the difference between those strains was more pronounced in the cells in the phase resistant to radiation killing. This finding is in agreement with those in hibernating eggs. It can be concluded from the findings that the strain differences observed in the radiosensitivity of hibernating eggs may be of an intrinsic nature. In the reciprocal crosses, it was shown that the sensitivity was under the control of the sensitivity of the maternal strains regardless of that of the parental strains. When females from different sensitivity strains were crossed to males of a fixed strain (pe : re), the sensitivity was markedly damaged depending on the sensitivity of each female. When fixed females were used, the difference in sensitivity was almost nil regardless of the sensitivity of the male parent. These findings suggest that the cytoplasmic effect may be operating for the differential sensitivity for different strains at an early developmental stage of embryos. However, it was demonstrated that no cytoplasmic effects in sensitivity were observed at the late stage of embryos. This indicated that the cytoplasmic effect on the differential strain sensitivity may be limited to the cells during the early cleavage stage. (auth)

2635 RADIATION-INDUCED CHROMOSOME DAMAGE IN HUMAN PERIPHERAL BLOOD LYMPHOCYTES IN VITRO. I. RBE AND DOSE-RATE STUDIES WITH FAST NEUTRONS. Scott, D.; Sharpe, Heather; Batchelor, A. L.; Evans, H. J.; Papworth, D. G. (Medical Research Council, Harwell, Eng. Atomic Energy Research Establishment, Harwell, Eng.). Mutat. Res., 8: 367-81 (Sept.-Oct. 1969).

Human peripheral blood lymphocytes were irradiated in vitro, before or after stimulation with phytohemagglutinin, with neutrons from uranium fission, at different doses and dose rates, or with acute x rays (250 kV). Cells were examined at their first mitotic division in culture for chromosome aberrations. An almost 1000-fold difference in neutron dose-rate (0.057 to 50 rad/min, doses up to 150 rad) did not change the frequency of aberrations in cells irradiated after stimulation. A small dose-rate effect was observed for cells irradiated in the nonstimulated condition but this was thought to be due to a differential stimulation of less heavily radiation-damaged cells. The data for the induction of dicentric aberrations by x rays were in agreement with Evans' earlier findings of an almost linear dose-response curve. Since the dose-response relationship after neutrons was linear, a mean relative biological effectiveness value of approx. 3.5, which did not vary much over the wide range of doses used, was obtained for the induction of dicentrics by fast neutrons (mean energy approx. 0.7 MeV) relative to x rays. (auth)

2636 FACTORS INFLUENCING CHROMOSOME ABERRATION YIELDS IN THE HUMAN PERIPHERAL LEUKOCYTE SYSTEM. Bender, M. A.; Brewen, J. G. (Oak Ridge National Lab., Tenn.). Mutat. Res., 8: 383-99 (Sept.-Oct. 1969).

The culture procedure for peripheral leukocyte tissue was considered a simple, unique method for studying radioinduced chromosome aberrations. Cells that can be stimulated to undergo transformation and cell division in culture were thought to constitute a population of uniform radiosensitivity. It was thus believed that as long as the investigator took the precaution to fix leukocyte cultures at a time that precluded the possibility of obtaining any cells in their second division in culture, the system would provide uniform quantitative estimates of radioinduced chromosome aberration yields. Experiments described in this paper suggest that these assumptions are erroneous. Successive samples of colchicine-metaphase chromosome preparations from the same culture indicate that with increasing time in culture, the aberration yield gradually rises to a peak, drops off, and then a second peak occurs later. The data also show the peak yield of aberrations occurring at a time when there is a significant frequency of cells in their second division in culture, as measured by either loss of acentric fragments or segregation of tritiated-thymidine label. This suggests the existence of two subpopulations of cells with differing radiosensitivities and rates of progression through the process of transformation to cell division. Regression analysis of the dose-response curves of the two-break aberrations shows that most of them result from two independent ionizing events. This is in accord with earlier work on the human leukocyte system and other cytological system but differs from that of Evans. (auth)

2637 NONRANDOM REJOINING IN THE FORMATION OF CHROMATID INTERCHANGES: VARIATIONS THROUGH THE CELL CYCLE AND THE EFFECT OF CHROMOSOME PAIRING. Brewen, J. G.; Olivieri, G.; Luippold, H. E.; Pearson, F. G. (Oak Ridge National Lab., Tenn.). Mutat. Res., 8: 401-8 (Sept.-Oct. 1969).

The relative frequencies of x-radioinduced symmetrical and asymmetrical chromatid interchanges were analysed as a function of the cell cycle. The asymmetrical type of interchange was the most common. When the proportions of symmetrical interchange at all sampling times were plotted, the resulting best line fit had a significant negative slope. This finding is interpreted to mean that rejoining to form interchange aberrations is not random and varies through the cell cycle. Further experiments were carried out on the types and frequencies of interchanges produced between paired sister chromosomes of diplochromosomes. There was a highly nonrandom formation of symmetrical and asymmetrical exchanges whether they occurred spontaneously or were induced by x rays or [^{3}H]-thymidine. The X-type symmetrical exchange was 6 to 20 times more frequent than the U-type asymmetrical exchange. These data are interpreted to mean that some preferential patterns of rejoining are determined by chromosome proximity and other spatial features that are variable throughout the cell cycle. (auth)

2638 ANALYSIS OF PHOTOENZYMATIC REPAIR OF UV LESIONS IN DNA BY SINGLE FLASHES. IV. MUTATIONS AFFECTING THE NUMBER OF PHOTOREACTIVATING ENZYME MOLECULES IN E. COLI CELLS. Harm, Walter (Southwest Center for Advanced Studies, Dallas). Mutat. Res., 8: 411-15 (Sept.-Oct. 1969).

The number of photoreactivating enzyme (PRE) molecules complexed with repairable uv-radioinduced lesions at a given moment may be measured in Escherichia coli by the amount of photoreactivation resulting from a single flash of light. By the use of this technique N-methyl-N′-nitro-N-nitrosoguanidine-induced mutants varying in their PRE content were isolated from E. coli, $_{-1}$. Three mutants with increased PRE content and one with complete lack of PRE are described and their possible use for analysis of the photoreactivation process is discussed. (M.M.B.)

2639 THE RADIATION SENSITIVITY OF NUCLEASE MUTANTS IN NEUROSPORA CRASSA. Uno, I.; Ishikawa, T. (Tokyo Univ.). Mutat. Res., 8: 239-46 (Sept.-Oct. 1969).

Nuclease mutants of two unlinked loci, nuc-1 and nuc-2, that show significantly reduced activity of nuclease N_3 were analyzed for radiation sensitivity. The nuc-2 mutants were more sensitive to both uv irradiation and N-methyl-N′-nitro-N-nitrosoguanidine treatment than the wild-type, but showed no such difference in γ ray sensitivity. The nuc-1 mutants showed no difference from wild-type in sensitivity to uv and γ irradiations and N-methyl-N′-nitro-N-nitrosoguanidine treatment. Mutations at both loci were without effect on the ability for photoreactivation. Neither nuc-1 nor nuc-2 mutations had any effect in homozygotes on either interlocal recombination between the linked genes, ad-8 and ylo-1, or interallelic recombination at the ad-8 locus. Since there is evidence indicating that the nuc-2 gene may be responsible for the activity of an inhibitor that binds with nuclease N_3' to produce nuclease N_3, it is suggested that one of the dark-repair enzymes may be inhibited more completely by the inhibitor altered by the nuc-2 mutation. (auth)

2640 THE INFLUENCE OF A MUTATION TO UV AND X-RAY SENSITIVITY ON THE γ-RAY INDUCTION OF REVERSION TO PROTOTROPHY IN E. COLI. Stern, M. G. (State Univ., Leiden). Mutat. Res., 8: 416-18(Sept.-Oct. 1969).

A nitrosoguanidine-induced mutation in a multiple auxotrophic strain of Escherichia coli K 12 resulted in a strain with increased sensitivity to uv and x radiation. The effects of γ radiation on mutation frequency (reversion to prototrophy) and survival in the radiosensitive mutant and its parent were studied in both N_2 and O_2 atmospheres. The parent exhibited lower mutation frequency per lethal hit when γ-irradiated in O_2 than when irradiated in a N_2 atmosphere. The radiosensitive mutant differed from its parent in being relatively unaffected in its mutation frequency response to the atmosphere. The γ-radioinduced mutation frequency per lethal hit was lower in the radiosensitive mutant than in the parent in both atmospheres, but the difference between the two strains was greater in the N_2 atmosphere. Possible mechanisms for these results are discussed. (M.M.B.)

2641 NON-RANDOMNESS IN THE DISTRIBUTION OF CO-γ-RAY-INDUCED GAPS BETWEEN CHROMOSOMES IN VICIA FABA. Lazanyi, A. (Agronomic Inst., Cluj). Mutat. Res., 8: 422-3(Sept.-Oct. 1969).

The distribution of gaps was compared to the distribution of chromatid interchanges, isochromatid aberrations, and true chromatid breaks between γ-irradiated chromosomes M and S of Vicia faba. On the basis of random distribution the M:S ratio would be expected to be 1:2.21 which corresponds to the proportional lengths of the chromosomes at metaphase. However, a ratio of 1:3.53 was observed when chromatid interchanges, isochromatid aberrations, and true breaks were recorded as a group and a ratio of 1:0.80 for gaps. The deviations of both groups from random distribution between chromosomes M and S were statistically highly significant. (M.M.B.)

2642 INHIBITORY EFFECT OF 5-FLUORODEOXYURIDINE ON THE REPAIR OF γ-RAY-INDUCED LESIONS IN BARLEY CHROMOSOMES. Yamamoto, Koji; Yamaguchi, Hikoyuki (Tokyo Univ.). Mutat. Res., 8: 424-7(Sept.-Oct. 1969).

Both post-irradiation centrifugation and pre-irradiation treatment with 5-fluorodeoxyuridine (FUdR) enhanced the yield of γ-radioinduced aberrations in chromosomes of Hordeum vulgare. Centrifugation became ineffective if not applied within 22 min after irradiation. The effect of FUdR was reversed by the addition of thymidine after irradiation. This reversal was not evident until several min after the addition of thymidine. If the irradiated seeds were centrifuged, thymidine was ineffective in reversing the enhancement produced by FUdR. It was concluded that FUdR acts differently than centrifugation in the enhancement of γ-radioinduced chromosome aberrations, and that FUdR causes the broken chromosome ends to remain open or available for rejoining. (M.M.B.)

2643 INHIBITION BY CAFFEINE OF THE REPAIR OF γ-RAY-INDUCED CHROMOSOME BREAKS IN BARLEY. Yamamoto, Koji; Yamaguchi, Hikoyuki (Tokyo Univ.). Mutat. Res., 8: 428-30(Sept.-Oct. 1969).

The effects of caffeine on the yield of γ-radioinduced chromatid aberrations in Hordeum vulgare are presented. Treatment with caffeine 30 min before irradiation resulted in a larger increase in chromatid aberrations than from either treatment alone. Treatment with caffeine 2 and 10 min after irradiation produced comparable increases. However, administration of caffeine 20 to 30 min after irradiation resulted in a yield of aberrations about equal to the sum of the effect of irradiation plus the effect of caffeine alone. It was concluded that caffeine inhibits the repair or rejoining of radioinduced chromatid breaks that would normally have been repaired within 30 min after irradiation. (M.M.B.)

2644 EFFECTS OF THE PYRROLIZIDINE ALKALOID HELIOTRINE ON CELL DIVISION AND CHROMOSOME BREAKAGE IN CULTURES OF LEUCOCYTES FROM THE MARSUPIAL POTOROUS TRIDACTYLUS. Bick, Y. A. E.; Jackson, W. D. (Univ. of Tasmania, Hobart, Australia). Aust. J. Biol. Sci., 21: 469-81(June 1968).

The radiomimetic properties of heliotrine were investigated and compared with x-ray effects by treatment of short-term cultures of peripheral leukocytes from the Tasmanian rat kangaroo or potoroo. Heliotrine caused an almost complete suppression of cell division in leukocyte cultures at a concentration of 2×10^{-4} M; below 1×10^{-6} M its effect on the mitotic index was slight. The mean interval for cells to enter first mitosis was extended by 10 hr with 5×10^{-5} M heliotrine. Both chromosome and chromatid breaks were produced at this latter concentration of heliotrine, the total damage being equivalent to that produced by 300 R of x irradiation delivered at 25 R/min. The chromosome breakage was considered to be true chromosome damage since it appeared in cells in first division following treatment. Thus it would appear that heliotrine is capable of breaking the chromosomes in G_1, i.e., before DNA synthesis. Breakage in G_1 was demonstrated by treatment with hydroxylamine and 8-ethoxycaffeine with which the action of heliotrine is compared. The distribution of damage by heliotrine and x irradiation showed a nonrandom pattern. The overdispersion is marked in heliotrine treatments, a pattern related to the distribution of heterochromatin. (BBB)

Health Physics and Safety

Refer also to abstracts 2317, 2417, 2868, and 2978.

Radioactive Contamination and Decontamination

Refer also to abstracts 2322, 2543, 2601, and 2657.

2645 (CEA-tr-R-1964) POISONING OF ANIMALS BY INHALATION OF RADIOACTIVE AEROSOLS. Dergachev, V. I. Translated from Gig. Sanit., 30: No. 6, 70-2(1965). 8p. (In French). Dep. CFSTI (U. S. Sales Only).

The Pestaner and Gevantman aerosol generator, consisting of a saline solution pulverizer and a quartz tube whose central section is placed in a tubular furnace, was used for the production of radioactive aerosols. The dispersion of the particles is dependent on the concentration of the solution. The complete system is enclosed in a low pressure chamber to avoid contamination outside the installation. The relation between the concentration of the solution and the dimensions of the particles obtained was determined. The installation was developed for the poisoning of animals by inhalation of radioactive aerosols. (J.S.R.)

2646 (IN-1310, pp 39-41) INDUSTRIAL HYGIENE. Coward, D. D.; Anderson, P. B.; Hanson, W. (Idaho Nuclear Corp., Idaho Falls).

The following aspects of industrial hygiene are discussed briefly: nonradioactive air pollution studies, radioactive waste management, solvent evaluation, annual industrial hygiene surveys, cafeteria inspection program, training programs, critical materials information, charcoal adsorber testing, sewage treatment operations, mercury spills, potable water, noise, carbon monoxide surveys, ventilation surveys, and design reviews. (H.L.W.)

2647 (JAERI-4048) REMOVAL OF DEPOSITED PLUTONIUM FROM BODY BY CHELATING AGENTS (REVIEW). Iwamoto, Junko; Fujita, Minoru (Japan Atomic Energy Research Inst., Tokai, Tokai Research Establishment). Apr. 1969. 33p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

For the purpose of removing plutonium from man, chelating agents, especially DTPA, are useful. However, at present, the method of administration is not fully established and the effectiveness of the chemicals also is not clear. Therefore, it is attempted in this report to survey the literature published from 1955 to 1968 and to summarize the present knowledge of the chelating agents which are being used for removal of plutonium. (auth)

2648 (ORNL-tr-1677) STUDY FOR THE ESTABLISHMENT OF STANDARDS FOR RADIOACTIVE WASTES IN HYDROBIOLOGICAL SYSTEMS. Technical Report of a Group of Experts. Translated for Oak Ridge National Lab., Tenn., from report EUR/C-1263/66. 30p. Dep. CFSTI.

The maximum limitation of radiation exposure of man constitutes an essential imperative for the protection of public health. With regard to the hazards of contamination due to the disposal of radioactive wastes in a hydrobiological system, it is evident that we can no longer simply limit ourselves to a consideration of the MPC for drinking water in order to make an objective evaluation of the possibilities of radioactive waste discharges. The formulation of the limiting radiological capacity of a hydrobiological system must consider all of the processes that modify the distribution of radioactivity in the ambient medium. The characterization and quantitative evaluation of these processes should permit a determination of this maximum quantity of radioactive substances that can be discharged into a hydrobiological system without exceeding the basic standards for the subsequent exposure dose of man. For a hydrobiological system, this radioactivity burden depends upon: the routes of transfer of the radioactivity to man; the nature of the radionuclides; and the concentration factors of the radionuclides in the ambient medium. (auth)

2649 (NYO-4039-1, pp 121-6) SOIL AND VEGETABLE ^{90}Sr AND ^{137}Cs LEVELS ON SITES UNDER CONTINUOUS CULTIVATION. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca).

Experimental plots kept under continuous cultivation show patterns of ^{90}Sr and ^{137}Cs levels from 1963 to 1968. Soil levels during this period were relatively consistent; apparently increased deposition was nearly matched by soil losses associated with normal cultivation practices. In contrast, vegetables generally showed declines in ^{90}Sr and ^{137}Cs content that followed lower deposition rate conditions from the atmosphere. (auth)

2650 (PEL-187) DECONTAMINATION OF RADIOACTIVELY CONTAMINATED MATERIALS. van der Westhuizen, H. J.; van Averbeke, J. W.; Bruyninckx, G. L. F. E. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). June 1969. 12p. Dep. CFSTI (U. S. Sales Only).

The most frequently occurring contamination mechanisms and factors influencing decontamination are summarized. Solutions and procedures for the decontamination of various types of surfaces, used at the AEB, and the success obtained, are reported. (auth)

2651 INVESTIGATION ON SORPTION OF STRONTIUM AND CESIUM BY SOILS OF BORG EL-ARAB DISTRICT. Farah, M. Y.; Abdel-Gawad, S.; Metry, E. (Atomic Energy Establishment, Inshas, United Arab Republic). Health Phys., 17: 711-15(Nov. 1969).

Studies were carried out to evaluate the effectiveness of Borg El-Arab soil samples for the concentration of fission products from liquid wastes. The sorption of cesium and strontium was investigated. With each isotope the exchange capacity, distribution coefficient, and selectivity coefficient was determined. Also the effect of other factors such as pH, the concentration of chemically similar elements present in solution, and heat treatment of the samples was studied. (auth) (UK)

Dosimetry and Monitoring

Refer also to abstracts 2429, 2439, 2452, 2458, 2463, 2464, 2497, 2505, 2506, 2596, 2812, 3492, 3800, and 3803.

2652 (AE-369) REPORT ON THE PERSONNEL DOSIMETRY AT AB ATOMENERGI DURING 1968. Carlsson, J.; Wahlberg, T. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Aug. 1969. 10p. Dep. CFSTI (U. S. Sales Only).

Results are given of personnel dosimetry at AB Atomenergi during 1968. Totally 25600 gamma films and 3900 neutron films were evaluated. Furthermore 1737 urine analyses and 1066 measurements of body activity were made. The external total body gamma dose for all employees (quarterly doses ≤ 100 mrem are not reported) corresponds to 136 manrem. The highest external total body gamma dose during 1968 to one person was 4500 mrem. (auth)

2653 (CONF-690501-6) FETAL RADIATION DOSE FROM MATERNALLY ADMINISTERED ^{59}Fe AND ^{131}I. Dyer, Norman C.; Brill, A. Bertrand (Vanderbilt Univ., Nashville, Tenn. School of Medicine). [1969]. 23p. Dep. CFSTI.

From 9th Annual Hanford Symposium on Radiation Biology of the Fetal and Juvenile Mammal, Richland, Wash.

Of all the segments in the population exposed to ionizing radiation, the most sensitive age group is the developing embryo. Occasionally, pregnant women are given diagnostic or therapeutic amounts of radionuclides, deliberately, or more usually, inadvertently. To correctly assess hazards from the exposure to ionizing radiation, the radiation absorbed dose to the fetus must be known. Calculations of the radiation dose to the fetus and the critical fetal organ were made for the radioisotopes, ^{131}I and ^{59}Fe. The critical fetal organ and the other necessary fetal parameters for the dose calculations were determined and dose measurements were made in nine fetuses. The self-dose from the isotope in the fetus or critical fetal organ plus the penetrating-radiation dose from the mother were considered in the dose calculations. Over a gestational stage from nine to 22 weeks, the total fetal dose from ^{59}Fe is about 38 rads per millicurie while the critical fetal organ for ^{59}Fe is the liver that receives a radiation dose of from 331 to 536 rads per millicurie. For ^{131}I, the total fetal dose varies from 0.796 to 3.00 rads per millicurie over the same gestational age while the critical organ for ^{131}I is the fetal thyroid that receives a radiation dose of from 715 to 5900 rads per millicurie. The amount of radioisotope quoted is that amount administered to the maternal unit. The formulations and considerations needed for the fetal dose calculations are included. (auth)

2654 (DPST-69-30-2) EFFECT OF THE SAVANNAH RIVER PLANT ON ENVIRONMENTAL RADIOACTIVITY. Semiannual Report, January-June 1969. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Aug. 1969. 18p. Dep. CFSTI.

This report, for the period January 1 through June 30, 1969, presents the results of the environmental monitoring program for the atmosphere, vegetation, milk, and water. The quantity of radioactive waste released by the Savannah River Plant to its environs was, for the most part, too small to be distinguished from natural background radiation or was obscured by fallout from offsite sources. Release of more than the usual amounts of ^{103}Ru in April and ^{244}Cm for a brief period in June caused detection of these radionuclides in air at several points near the plant boundary. The temporary levels however were far below the respective concentration guides. Beta activity in air was about the same as that observed for the same period of 1968 and was a twofold increase over the previous six-month period. Radioactive materials in fish flesh continued to be far below levels considered significant from a health standpoint. The average concentration of any radionuclide in river water at Highway 301 did not exceed 0.3% of the concentration guide. (auth)

2655 (LA-4223) EVALUATION OF DEOXYCYTIDINURIA IN THE SUBHUMAN PRIMATE AS A RADIATION BIODOSIMETER. Murray III, Arthur (Los Alamos Scientific Lab., N. Mex.). May 1, 1969. Contract W-7405-eng-36. 7p. Dep. CFSTI.

No deoxycytidinuria resulting from exposure to sublethal (acute) or lethal doses of whole-body ionizing irradiation delivered at low dose rates (chronic) could be demonstrated in the rhesus monkey. A new chemical method of deoxycytidine determination was developed, consisting of column chromatographic fractionation from large samples of urine and subsequent assay by a sensitive colorimetric method for 2-deoxyribose. (auth)

2656 (NRL-F-34) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND MEASUREMENTS ON SAMPLES FROM FIJI AND RAROTONGA. Quarterly Report, January-March 1969. (National Radiation Lab., Christchurch (New Zealand)). 11p. Dep. CFSTI (U. S. Sales Only).

Results of routine monitoring of fallout in air, rain, and milk samples during the first quarter 1969 are tabulated in this Report. These results are summarized on a quarterly basis and are presented graphically, together with results from previous Quarterly Reports during 1968. (auth)

2657 (NYO-4039-1, pp 127-33) URINARY SAMPLING TECHNIQUES FOR ESTIMATING ^{90}Sr IN DIETS. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca).

Studies have shown the validity of utilizing urinary ^{90}Sr analyses to estimate ^{90}Sr dietary levels. Results from two special urinary sampling studies are given as examples of this technique. Difficulties in analytical techniques have prevented full use of the procedures and estimating capabilities that were developed from this concept. (auth)

2658 (SJC-A-69-2) ON THE LOGICAL AND CONCEPTUAL FOUNDATIONS OF RADIATION DOSIMETRY. Katoh, Kazuaki (Tokyo Univ. (Japan). Inst. for Nuclear Study). June 1969. 16p. Dep. CFSTI (U. S. Sales Only).

The currently used system of radiation dosimetry that is based on the recommendations made by ICRU and ICRP are criticized from the view point of logical consistency. Proposals are made to construct a better system. (auth)

2659 RADIOGRAPHIC DEVELOPMENT OF SKELETAL LESIONS IN MAN MANY YEARS AFTER ACQUISITION OF RADIUM BURDEN. Hasterlik, R. J. (Argonne Cancer Research Hospital, Ill. Univ. of Chicago); Miller, C. E.; Finkel, A. J. Radiology, 93: 599-603(Sept. 1969).

Three hundred and eight studies of skeletal radiography and radium body content of 219 former radium dial painters were completed. Calculations based on either a power function or a sum of three exponentials yielded estimates of dose rates and of accumulated total dose at times ranging from one day to forty years after cessation of ingestion of ^{226}Ra contained in radium dial paint. Estimates of the amount entering the bloodstream during each working day and the total entering the bloodstream during each person's occupational exposure period were calculated. Scoring of radiographically demonstrable skeletal lesions was done on a numerical and clinical impression basis. Positive correlations with a probability of 0.001 exist for the entire group versus terminal body content, quantity of radium entering the bloodstream, dose rate, and accumulated dose at various times from one day to forty years after cessation of exposure. This same high degree of correlation holds within the group listed as advanced but fails within the groups of lesser severity. (auth)

2660 DOSE OF RADIATION ADMINISTERED TO PATIENTS WITH TRADITIONAL AND INTENSE RADIODIAGNOSTIC TECHNIQUES. Bossi, R.; Ciancia, C.; Coucourde, F.; Rovera, S. Nunt. Radiol., 34: 575-84(June 1968). (In Italian).

The dose administered to patients during radiographic exami-

nations of the digestive tract and the gall-bladder were compared by employing the traditional techniques and the luminosity amplifier. The use of the luminosity amplifier diminished the dose of radiation to the patient in a ratio of 5 to 1 for the examination of the digestive tract and of 3.5 to 1 for examination of the gall-bladder. (auth)

2661 DETERMINATION OF DOSAGE DISTRIBUTION BY COMPUTER IN RADIOTHERAPY. Becker, J.; Fehrentz, D.; Kuttig, H. (Univ., Heidelberg). Cesk. Radiol., 23: 3-8(Feb. 1969). (In German).

The general principles of calculating dose distribution in teletherapy with γ radiation and high-voltage x radiation are discussed. The application of computers for this purpose is evaluated. Some specific methods are briefly explained with clinical examples. (H.B.G.)

2662 DENSITOSERIGRAPHIC METHOD IN THE ANALYSIS OF ISODOSE CURVES (CIRCULAR ABACUS FOR CALCULATION IN GAMMAGRAPHY AND IN ISODOSE CURVES). Abad, R.; Lerena, R.; Perez-Palencia, M.; Perez-Modrego, S. Acta Oncol., 6: 86-104(Jan.-June 1967). (In Spanish).

Isodose distribution curves are discussed for γ radiation. Methods using analog and digital computers are evaluated. An inexpensive and practical technique employing photographic plates was developed and the details of procedure and results are presented. (H.B.G.)

2663 SIMPLE STATISTICAL TEST FOR SIGNIFICANCE OF ENVIRONMENTAL RADIOACTIVITY DATA. Miller, W. R. (General Dynamics Corp., Fort Worth, Tex.). Health Phys., 17: 736-8(Nov. 1969).

A simple statistical treatment for analysis of routine environmental monitoring sample data has been developed at Fort Worth. The method which is an adaptation of the distribution — Frere-Wilcoxan-Mann-Whitney test, described in NBS Handbook 91, has provided reliable interpretations of relationships between measured radioactivity concentrations and distance and direction relative to the General Dynamics Nuclear Reactor Facility. It may be adapted easily to any routine monitoring program. (UK)

2664 LATENT IMAGE FADING IN PERSONNEL MONITORING NEUTRON FILM. Kahle, J. B.; Arnett, E. N.; Meyer, C. T. (Mound Lab., Miamisburg, Ohio). Health Phys., 17: 735-6(Nov. 1969).

The results of two independent studies with Kodak NTA personnel monitoring film indicate that although latent image fading of neutron tracks is a function of average energy, the degree of fading cannot be predicted on the basis of average energy alone; the entire neutron spectrum must be considered. (UK)

2665 CALCULATION OF MAXIMUM PERMISSIBLE LUNG BURDEN OF URANIUM MIXTURES. Helgeson, G. L. (Helgeson Nuclear Services Inc., Pleasanton, Calif.). Health Phys., 17: 734(Nov. 1969).

To obtain a proper evaluation of the maximum permissible lung burden (MPLB) from uranium fuels it is necessary to know the percentages of various uranium isotopes present in the material being used. Mass spectrographic analyses should therefore be made. The MPLB may then be calculated using the equation and data given in ICRP recommendations. An example is given. (UK)

2666 DIRECT COUNTING OF HAIR SAMPLES FOR ^{32}P ACTIVATION. Hankins, D. E. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 17: 740-2(Nov. 1969).

The ^{32}P activation of the sulfur in the hair can be used to assist in determining the neutron exposure received by a person during a criticality accident. A technique for counting samples of ^{32}P-activated hair which does not require a chemical separation procedure, has a greater accuracy and does not destroy the original hair sample is described. (UK)

2667 DOSIMETRY OF X-RAYS, γ-RAYS, AND NEUTRONS WITH A FERROUS SULFATE SOLUTION. Antoku, Shigetoshi; Sunayashiki, Tadashi (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 10, 27-31(1969). (In Japanese).

Absorbed radiation doses from x-rays (180 kVp, HVL: 1.18 mmCu), γ rays (^{60}Co), and neutrons (T, d reaction, 14 MeV) were measured using a ferrous sulfate dosimeter (Fricke dosimeter). The amounts of ferric ions produced by x rays and γ rays were measured by the absorption at 304 mμ with 5000 rad. Because of the generator's low neutron output and the relatively low chemical yield for neutrons, the latter were measured by thiocyanate method with a dose of 1200 rad. The chemical yield per unit absorbed energy (G-value) used were 15.2 for x rays and 15.6 for γ rays, the averages of these reported, respectively. Neutron doses were calculated for the two G-values, 10.5 and 11.5, for 14 MeV neutrons. (C.H.)

2668 DISPOSAL OF RADIOACTIVE WASTES FROM U. S. NAVAL NUCLEAR-POWERED SHIPS AND THEIR SUPPORT FACILITIES, 1968. Miles, M. E.; Mangeno, J. J. Radiol. Health Data Rep., 10: 375-7(Sept. 1969).

Data on the disposal of radioactive wastes from U. S. Naval nuclear-powered ships and their support facilities and the results of environmental monitoring performed to confirm the adequacy of waste disposal limits and procedures are summarized. The data, presented in tabular form, include: the total amount of long-lived radioactivity discharged as liquid wastes from U. S. Naval nuclear-powered ships into various harbors during 1964 to 1968; the total radioactivity and volumes of solid radioactive wastes disposed of by facilities supporting the nuclear-powered ships during 1964 to 1968; and a summary of 1968 surveys for ^{60}Co in bottom sediments of U. S. harbors where nuclear-powered ships were regularly based, overhauled, or built. In addition to the bottom sediment monitoring, film badges posted outside the boundaries of areas where radioactive work is performed showed that radiation exposure to the general public outside these facilities was not above that received from natural background radiation levels. (E.R.B.)

2669 WHOLE BODY COUNTING WITH THE I.D.L. SCANNER. Koschel, K. W. (Cancer Inst., Melbourne). Australas. Bull. Med. Phys. Biophys., No. 41, 3-11(Aug. 1969).

A technique is described for the simple assessment of tracer and therapy doses in the whole body using the I.D.L. Scanner, equipped with two modified slit collimated scintillation counters. One counter is positioned above the patient and one below. The counters are vertical, the collimator slits are parallel and at right angles to the longitudinal couch movement. A formula for the relationship between source count and isotope concentration, couch speed, source to crystal distance and collimator slit width is given. A major contribution to error is absorption of radiation by tissue overlying the source. This effect may be minimized by also counting some of the scattered radiation. Results are given for measurements of a tissue-equivalent phantom using ^{99m}Tc, ^{131}I, ^{51}Cr, ^{85}Sr and ^{59}Fe to determine how much scatter needs to be counted. The effects on the measured count of statistical and systematic errors are discussed. The lower limit of activity which may be detected by the technique described is of the order of 3 to 5 μCi. The total error is a retention ratio on a 50% retention basis, including systematic errors could be of the order of 15% for 5 μCi doses and close to 21% for 1 μCi doses. (Australia)

2670 THE FILM BADGE SERVICE IN NEW SOUTH WALES. Fleischmann, A. W. J. Proc. Roy. Soc. N. S. W., 101: 119-27 (May 1968).

A historical background to the Film Badge Service in New South Wales is presented. Details on how the service operates, both scientifically and clerically, the results to date, the accuracy of film badges in general, and some other methods of personnel dosimetry are examined. The Film Badge Service in New South Wales commenced in November, 1959, with 16 organizations participating and 155 persons actually wearing the badges. By December, 1967, the number of organizations using the Service had grown to 935 with 2951 persons actively involved. At present, a computer program is used for all the calculations. The results described show that, with improved equipment and techniques, industrial radiographers are tending to fall into lower accumulated dose groups. In a discussion of the accuracy of film badges it was shown that it is useless to quote an accuracy of better than 20%, particularly, in cases where usage of the films and the radiation to which the films have been exposed is only known approximately. It is suggested that a thermoluminescent dosimetry system would be more accurate than a film badge one, but consideration of economics makes it unlikely that a change to this system will occur in the near future. Furthermore, there is doubt whether the increased accuracy would be worth the added expense. (BBB)

2671 MEASUREMENT OF HIGH DOSE RATES DELIVERED BY ^{60}Co SOURCES WITH THE AQUEOUS SILVER NITRATE SYSTEM. Law, J. J. (Longwood Coll., Farmville, Va.). Health Phys., 17: 338-40(Aug. 1969).

The induced activity of a metastable isomer produced by isotopic photonuclear excitation of a ground state isomer can be used as a measure of exposure and dose rate, flux density, or source activity when all other parameters are fixed, and it was considered that Ag might be used in this connection, taking advantage of the relatively short irradiation and counting periods needed, the half-lives of ^{107m}Ag and ^{109m}Ag being 44.3 and 40 sec., respectively. The relationship between the dose rate delivered by a ^{60}Co source and induced γ-activity in aqueous silver nitrate is reported. Advantages and limitations of the method are discussed. (UK)

2672 TAINTED RADIATION. Morgan, Karl Z. Sci. Technol. (N.Y.), No. 90, 46-50 (June 1969).

Arguments are advanced for the relatively greater hazard of environmental radiation levels from medical and natural sources as compared with nuclear technology sources in population exposure. The atom bombing of Hiroshima and Nagasaki initiated a lasting fear of atomic radiation among the world's population. While people quickly react to oppose nuclear power plant construction in their neighborhood, they generally fail to recognize more intense exposures such as those from diagnostic x-ray units. In factories, switches and condensers, operated in a vacuum, can also act as radiation sources, and in homes color television sets and radar ranges may account for substantial exposure. Background radiation from cosmic rays produce an annual exposure rate 50 times that ever achieved by radiation from nuclear weapon testing. More radiation is present in the atmosphere from one year's burning of coal (radon) than is released from an atomic reactor operated for 50 yr. Exposure to ionizing radiation from commercial, industrial, medical research, and consumer product electronic devices operating in the voltage range of 10 to 200 KV is described. Some of these devices, such as diffraction analyzers and electron microscopes, have been recognized as potentially dangerous x-ray sources for many years, but such equipment in universities and industry still leads to many cases of overexposure due to improper supervision and the failure of some operators to recognize conditions whereby x rays may leak from these devices. Appreciable exposure may also result from radioisotopes used in a number of small devices to measure thickness (gauges), as electrostatic charge eliminators, as a weak source (watch dials, instrument dials, emergency lights), and as electron sources (certain instruments and radio tubes). Advantages of nuclear applications in industry are weighed against hazards. (BBB)

Radiation Protection

Refer also to abstracts 2818 and 2822.

2673 RADIATION SAFEGUARDS FOR MICROWAVE OVENS. Tibbs, C. E. (Dysona Industries Ltd., Wokingham, Eng.). Non-Ionizing Radiat., 1: 73-6 (Sept. 1969).

The safety and interference aspects of microwave ovens are discussed, together with the relevant standards. The method of field measurement in the vicinity of an oven and the user-protection devices included in the construction are described. (auth) (UK)

2674 EMPIRICAL BUILD-UP FORMULA. Arras, J. M. (Armed Forces Radiobiology Research Inst., Bethesdon, Mich.). Health Phys., 17: 738-9 (Nov. 1969).

An empirical formula is given for use in field problems involving the shielding of radioactive sources where an estimate of the gamma dose build-up is required. The formula is a calculation method for certain defined conditions. It is accurate to within a factor of 1.6 for the conditions specified. (UK)

2675 DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS. Sax, I. N. New York, Reinhold Book Corp., 1968. 1251p. $27.00.

A theoretical part of this reference work (11 sections) deals with: toxicology (toxicity ratings, routes of absorption, prevention, etc.); ventilation control (local exhaust ventilation, hoods, fans, piping, testing); respiratory protection and personal hygiene (atmospheric hazards, testing and care of respirators); environmental pollution (air and water pollution, disposal of residues and wastes); radiation hazards (radioisotopes, radioactive decay, absorption, radiation units and radiation effects); industrial fire protection and fire extinction, etc.; storage and handling of hazardous materials (explosives, flammable liquids, industrial disaster control); control of radiation (sources of contamination, prevention, radioisotopes, effluent disposal); allergic disease in industry; food additives; transport of dangerous goods. The remaining section of the book, constituting the major part of the work, provides data (general information; analysis of hazards, preventive measures) on over 12,000 hazardous materials, dealt with in alphabetical order. (Occup. Safety and Health Abstr.)

2676 DENTAL RADIOLOGY TODAY. Wege, William R. (Medical Coll. of Georgia, Augusta). J. Ga. Dent. Ass., 42: 24-6 (July 1968).

Effect of the following six factors in reducing patient and operator exposure in dental radiology is reviewed: fast film, filtration, collimation, technique, kilovoltage, and film processing. The use of fast film reduces to $\frac{1}{4}$ the exposure necessitated by medium-speed film. High-speed film requires greater care on the part of the operator since it is more sensitive to all factors that contribute to film fog. The inherent filtration in the x-ray machine should be determined and a sufficient thickness of Al added to bring the combined thickness to 2.50 mm. A method of determining adequate filtration is described. The x-ray beam should be limited in diameter to the area of investigation. Collimation of the x-ray beam is obtained by inserting a lead diaphragm in the path of the beam. The diameter of the radiation beam used for intra-oral radiographs should be no more than 2.75 in. at the skin surface. Film positioning and proper angulation form the basis for acceptable technique. Radiation exposure to the patient can be reduced considerably by taking only those films that are required and being careful to make correct exposures the first time. Use of higher kilovoltage produces x rays of greater penetrating power and fewer x-ray photons are required to expose the film. Higher kilovoltage may also afford a greater diagnostic value to the radiograph. It is advised to follow the manufacturer's time and temperature suggestions on developing procedures. (BBB)

2677 RADIATION PROTECTION IN THE CASE OF WORKING WITH ^{192}Ir. Kolb, K. (Zerstoerungsfreie Pruefungen und Strahlenschutzmessungen, Stuttgart). Atompraxis, 15: 312-15 (Sept.-Oct. 1969). (In German).

The type, energy, and intensity of ^{192}Ir-scattered radiation were investigated and consequences in the field of personnel monitoring with film badges are discussed. (auth)

Safety Procedures

Refer also to abstract 2687.

2678 (IN-1310) HEALTH AND SAFETY BRANCH PROGRESS REPORT, 1968. McCaslin, J. W. (ed.) (Idaho Nuclear Corp., Idaho Falls). Aug. 1969. Contract AT(10-1)-1230. 52p. Dep. CFSTI.

The Idaho Nuclear Corporation Health and Safety Annual Progress Report for 1968 is comprised of the major accomplishments of the various sections of the Health and Safety Division. It includes significant studies, policies, experiments, projects, pamphlets, and reports produced during the year. Separate abstracts were prepared for six sections of the report. (auth)

For abstracts of individual sections see: 2541, 2646, 2679, 2680, 2681, and 3052.

2679 (IN-1310, pp 35-7) HEALTH AND SAFETY DESIGN REVIEW. Davis, D. A. (Idaho Nuclear Corp., Idaho Falls).

A list of 44 reviews of design criteria, construction designs, and proposals to the operating committee is presented. A brief comment on interesting aspects of each is included. (H.L.W.)

2680 (IN-1310, pp 38) INDUSTRIAL SAFETY. (Idaho Nuclear Corp., Idaho Falls).

Methods for improving the evacuation system for personnel of the TRA-603 Neutron Radiographic Facility are discussed. Improvements in the construction of staging areas, a weather tower, neon directional signs, an alarm system, and a lock system on perimeter fence truck gates are described. (H.L.W.)

2681 (IN-1310, pp 42-61) HEALTH AND SAFETY SERVICES SECTION. (Idaho Nuclear Corp., Idaho Falls).

Research projects conducted by the Research Section of the Health and Safety Services are described. Experiments were conducted on submicron particle sizing using the following methods: diffusion chamber system; particle-laden air bubbled through epoxy resin; and migration time ultracentrifuge method with a silicone oil and organic solvent solution as a gas-washing condition. Investigations on the use and labeling of radioactive waste containers included studies on liquids in hot waste boxes; noncompatible chemicals and pyrophoric materials; excessive weight; excessive radiation; use of hot containers for cold waste; and standardization of containers. Research on emergency handling of biological samples and dosimetry devices included whole-body counting, urine analysis, fecal analysis, and badge pulls. Research was conducted on safety shoes used at the Chemical Processing plants, surgeon's caps, and x-ray training. A standardized outline and visual aids were developed by plant construction health physicists for indoctrination lectures presented to construction personnel working in controlled areas. The curriculum for the master's degree Health Physics Program at the University of Idaho is discussed, and courses leading to a certificate in health physics are listed. (H.L.W.)

2682 INTERNAL CONTAMINATION OF CYCLOTRON WORKERS: REPORT OF CASES. Konishi, Emiko; Ono, Michizane (Tokyo Univ.). Hoken Butsuri, 4: 537-43 (Sept. 1969). (In Japanese).

A study on internal contamination of 21 cyclotron workers in two establishments is reported. The relation between the incidence of internal contamination and the environmental conditions of the

working area is traced. Factors concerned with the incidence of internal contamination area were: environmental contamination in working area, poor experience of a worker in operation, unreasonable increase in working frequency and intensity, indifferent attitude towards radiation safety, and carelessness about the apportionment of work to operators. From a health physics standpoint, emphasis is placed upon the importance of planning and training in cyclotron operation. (NSA of Japan)

2683 AN APPLICATION OF THE LOGNORMAL AND THE ROSIN–RAMMLER FUNCTIONS TO THE RADIOACTIVE SURFACE CONTAMINATION DATA IN CONTROLLED WORKING AREAS. Matsui, Hiroshi (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri, 4: 544-9(Sept. 1969). (In Japanese).

Application of the lognormal function to the particle size distribution of radioactive aerosol, radiation dose rate in controlled working areas, and radioactive air concentration was investigated by a few workers. The distribution function on surface contamination data collected routinely in controlled working areas is discussed. It is shown that the data obey the Rosin–Rammler law rather than the lognormal one. (NSA of Japan)

2684 THE STATE OF HEALTH OF WORKERS EXPOSED TO RADIOFREQUENCY RADIATION IN INDUSTRIAL ESTABLISHMENTS AT BRNO. Skiensky, B.; Nedbal, J.; Kakova, L. Prac. Lek., 20: 363-6(Sept. 1968). (In Czech).

Nineteen female and 8 male workers exposed on average for 6 years to radiofrequency radiations emitted by radar installations, plastics-welding units, etc. were examined. The daily radiation dose received was less than the maximum permissible dose (80 V/m); in certain cases, the hands of workers were exposed to field intensities of up to 121 V/m. 13 women (48% of all subjects examined) exhibited a neurasthenic syndrome with headaches, indigestion, and fatigue; in 9 cases (33%) the authors found other causes than radiofrequency radiation for this syndrome. Slight changes in the electroencephalograms of 4 women (15%) exposed for more than 6 years were the only symptoms attributable to the effect of radiofrequency radiation. (Occup. Safety and Health Abstr.)

2685 LASER INJURIES IN LABORATORIES AND INDUSTRY. Geeraets, W. J. Arbeitsmed. Sozialmed. Arbeitshyg., 3: 325-7(Dec. 1968). (In German).

Following a review of energy densities (which vary with the type of laser) that may affect the retina of the eye, the influence of the spectral characteristics of the eye on possible injury is examined. Particular attention is paid to retinal injuries of varying severity caused by reflected laser light and to the hazards of irradiation in the ultraviolet and infrared ranges. Preventive measures include: thorough instruction of personnel; wearing of safety spectacles incorporating filters adapted to the type of laser used; use of dark, mat colors in workplaces; use of blinker lights or closing of workplace during laser operation. The difficulty of detecting clinically small lesions of between 20 and 40 μm in diameter is pointed out. (Occup. Safety and Health Abstr.)

2686 PRESENT-DAY VIEWS ON THE CONSEQUENCES OF PROLONGED EXPOSURE TO THE ACTION OF SUPER-HIGH-FREQUENCY ELECTROMAGNETIC FIELDS. Goshev, Khr.; Kachulev, V.; Vulkov, A. Voenno Med. Delo, 24: No. 3, 3-8(1969). (In Bulgarian).

The subject of harmful effects arising as a result of exposure to the action of superhigh-frequency electromagnetic fields is reviewed for the guidance of military physicians under subdivisions of effects on the nervous system, the cardivascular system, the endocrine system, and the blood. Mutagenic effects are also mentioned briefly. Three stages of development of the pathological condition that arises are described, the first or preliminary, the second, which is reversible, and the third (that of asthenization), in which only some of the lesions that have developed are completely reversible. Generally strengthening therapy, administration of sedatives and ginseng, and rest at health resorts are recommended as treatment for patients in the second stage. (JPRS)

Legal Aspects

Refer also to abstract 2658.

2687 (CEA-CONF-1338) COOPERATION ON THE MATTER OF NUCLEAR ACCIDENTS. Bresson, Gilbert (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 27p. (In French). (CONF-690509–3; SM–119/1). Dep. CFSTI (U. S. Sales Only).

From Symposium on the Handling of Radiation Accidents, Vienna, Austria.

The cooperation necessary between the specialized services (hospitals and laboratories) and the nuclear establishments in the event of a nuclear accident to an individual is summarized. The national and international agreements that should exist are indicated. The primary functional and psychological problems connected with the treatment of a person involved in a nuclear accident are connected with the specificity of the consequences of radiological injury. The infrastructure already existing in France in the region of the individual accident is outlined for the case of contamination. (J.S.R.)

2688 ACTIVITIES OF THE NATIONAL INSTITUTE OF RADIOLOGICAL SCIENCES IN FISCAL 1969. Kagaku Gijutsucho Geppo, No. 154, 24-7(June 1969). (In Japanese).

Since its establishment in July 1957, the National Institute of Radiological Sciences (NIRS) has engaged in research and investigation of radiation injuries, their prevention, diagnosis and therapy, and in the medical applications of radiations, and the training of the personnel. Features of the NIRS in fiscal 1969 are the special research subjects (internal exposures due to plutonium and transplantation of blood-making organs in the radiological-science field), installation of an on-line electronic computer in the data center, and strengthening of the Tokai Branch for oceanographic surveys. The total budget for the year is 801 million dollars, an increase of 63 million over the previous year. The program for the activities of NIRS in fiscal 1969 is described as follows: special research works; specific research works; routine research works; oceanographic surveys; radioactivity investigations; outside research workers; technologies in general; training of personnel; and hospitals. (NSA of Japan)

2689 PROCESS OF FIXING CIVIL LIABILITY DERIVING FROM ATOMIC ENERGY. Gay De Montella, R. Rev. Juridica Cataluna, No. 66, 845-60(Oct.-Dec. 1967). (In Spanish).

When a nuclear accident occurs, the victim can reclaim indemnification for damages and bias up to the maximum amount guaranteed by the state. This exonerates the operator of supplementary payments when the amount of the accident exceeds that of the private insurance of the operator. A common compromise of the contracting parties would cover the part of the damage exceeding the guaranteed amount. The convention between O.E.C.E. and EURATOM would permit the damage from a nuclear accident to be covered and to obtain a complete coverage of the damage. (tr-auth)

2690 STATUS OF LEGISLATION ON IRRADIATED FOOD. Goresline, H. E. pp 478-81 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

For some 14 years there has been intensive research on the feasibility and practicability of the use of ionizing radiation as a food processing method. This research has shown that there is promise for such processing with certain food commodities and that the method can be applied in competition with the other conventional methods. These facts have made it evident that commercial irradiated food products will appear on the market and eventually will become articles of international trade. Before such use can be made of any process there must be proof that it is safe, that the processed food products are wholesome and nutritious, and that they have been processed under the proper conditions of quality and sanitary and public health control. The fact that control is necessary to assure such conditions has given rise to the promulgation by individual countries of legislation and regulations pertaining to each step in the procedure towards the offering for sale of irradiated items of food. A survey of world legislation on food irradiation as it now stands is given. Examples are given of the type and coverage of various control measures and the procedures that are followed in arriving at the approval of individual items for human consumption. Also presented are some of the testing procedures used to establish the wholesomeness of irradiated food, including animal feeding and microbiological studies. It is against this background that the irradiation processing regulations for fish and seafoods are discussed. (auth) (UK)

Medicine

2691 PROGRAM OF THE OPERATION FOR FISCAL 1969 OF THE NATIONAL INSTITUTE OF RADIOLOGICAL SCIENCES. Hoshasen Kagaku, App., 12: No. 4, 40p.(Apr. 1969). (In Japanese).

The Institute, since its establishment in 1957, has engaged in the research and investigation on radiation injuries, their preven-

tion, diagnosis and therapy, medical applications of radiations, and the training of personnel in the field. Some salient points in fiscal 1969 are the new installation of a data-processing center in the Technology Division, promotion of the operation of concerned laboratories, and strengthening of the Tokai Branch to forward oceanographic surveys. Total allocated funds are Y802 million, an increase of Y63 million from the previous year. The operation program for fiscal 1969 (starting in April) is described, under the categories of special, specified, and routine researches, oceanographic surveys, radioactivity investigations, state-of-affairs surveys, research services, training and education, and hospitals. An appendix of details of research works in the categories is also given. (TSS) (NSA of Japan)

2692 BRITISH EMPIRE CANCER CAMPAIGN FOR RESEARCH. FORTY-SIXTH ANNUAL REPORT, 1968. Brit. Empire Cancer Campaign Res., Annu. Rep., 1-477(1968).

Nineteen separate abstracts were prepared for inclusion in NSA. Research conducted by the various branches of the campaign is presented as brief summaries. Most of the work is arranged by the participating institution. In addition, a number of individual reports are presented. Indexes for subject matter and authors are included. (C.O.)

For abstracts of individual sections see: 2693–2711.

2693 INSTITUTE OF CANCER RESEARCH: ROYAL CANCER HOSPITAL. British Empire Cancer Campaign for Research., Annu. Rep., 1-100(1968).

Research summaries are presented for the departments involved. The Chester Beatty Research Institute and the Department of Clinical Research included sections on carcinogenesis, chemotherapy (experimental and clinical), biochemistry, immunology (experimental and clinical), cell surface studies, cell and tissue differentiation, genetics, cytogenetics, tumor pathology, invasion and metastasis, and social medicine. Other departments reporting are biophysics, physics, and radiotherapy. (C.O.)

2694 THE RESEARCH LABORATORIES OF THE MIDDLESEX HOSPITAL. British Empire Cancer Campaign for Research., Annu. Rep., 101-15(1968).

Brief summaries of research activities in bladder cancer, carcinogenesis biochemistry, steroid metabolism, and azo dye carcinogenesis are presented. Also included are reports of activities of the Institute of Nuclear Medicine and the Department of Physics Applied to Medicine. (C.O.)

2695 GUY'S HOSPITAL MEDICAL SCHOOL. British Empire Cancer Campaign for Research., Annu. Rep., 116-19 (1968).

Brief summaries of research activities in the following departments are presented: endocrine, physics, radiotherapy, and surgery-breast clinic. Included are both basic and clinical studies. (C.O.)

2696 KING'S COLLEGE HOSPITAL MEDICAL SCHOOL. British Empire Cancer Campaign for Research., Annu. Rep., 120-4(1968).

Brief summaries of research conducted by the departments of hematology, medicine, morbid anatomy, biophysical and immunological aspects of cancer, and surgery are presented. (C.O.)

2697 MOUNT VERNON HOSPITAL AND RADIUM INSTITUTE, NORTHWOOD, MIDDLESEX. British Empire Cancer Campaign for Research., Annu. Rep., 127-42(1968).

Brief summaries of research conducted by the Department of Experimental Pathology, the Physics Department, and the British Empire Cancer Campaign Research Unit in Radiobiology are presented. (C.O.)

2698 THE ROYAL COLLEGE OF SURGEONS OF ENGLAND. British Empire Cancer Campaign for Research., Annu. Rep., 143-7(1968).

Brief summaries of research conducted by the departments of anatomy, pathology, and dental science are presented. (C.O.)

2699 ST. GEORGE'S HOSPITAL MEDICAL SCHOOL. British Empire Cancer Campaign for Research., Annu. Rep., 169-74(1968).

Brief summaries of research conducted by the departments of chemical pathology, neurosurgery, surgery, and histopathology are presented. (C.O.)

2700 ST. MARY'S HOSPITAL MEDICAL SCHOOL. British Empire Cancer Campaign for Research., Annu. Rep., 175-81(1968).

Brief summaries of research conducted by the surgical unit and the departments of chemical pathology, pathology, bacteriology, virology, and experimental pathology are presented. Both animal research and clinical studies on man are included. (C.O.)

2701 UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL. British Empire Cancer Campaign for Research., Annu. Rep., 182-91(1968).

Brief summaries of research conducted are presented. Included are biochemical and metabolic studies of cancer patients, radiotherapy studies, and reports of the obstetric unit and the physical department. (C.O.)

2702 THE CANCER RESEARCH DEPARTMENT OF THE WESTMINSTER HOSPITAL. British Empire Cancer Campaign for Research., Annu. Rep., 192-9(1968).

Brief summaries of research conducted by the departments of chemical pathology, clinical histochemistry and cytology, radiotherapy, and physics (includes radiobiology) are presented. (C.O.)

2703 CANCER RESEARCH COMMITTEE OF THE UNIVERSITY OF BRISTOL. British Empire Cancer Campaign for Research., Annu. Rep., 203-8(1968).

Brief summaries of research conducted are presented. Included are reports of the Pathology Research Laboratory (Bone Tumour Registry) and the departments of surgery, medicine, bacteriology, and radiotherapy and medical physics. (C.O.)

2704 THE CAMBRIDGE UNIVERSITY CANCER RESEARCH COMMITTEE OF THE BRITISH EMPIRE CANCER CAMPAIGN FOR RESEARCH. British Empire Cancer Campaign for Research., Annu. Rep., 209-20(1968).

Brief summaries of research conducted by the individual departments are presented. Included are the Department of Radiotherapeutics, the Radiotherapeutic Center, the Department of Animal Pathology, the Department of Biochemistry, the Department of Colloid Science, and the Department of Pathology. (C.O.)

2705 STRANGEWAYS RESEARCH LABORATORY, CAMBRIDGE. British Empire Cancer Campaign for Research., Annu. Rep., 221-30(1968).

Brief summaries of research conducted are presented. Included are the following topics: developmental studies; cytology; carcinogenesis (with emphasis on metals); oxidative processes; endocrine studies; biochemical studies; and radiosensitivity. (C.O.)

2706 UNIVERSITY OF NOTTINGHAM. British Empire Cancer Campaign for Research., Annu. Rep., 231-9(1968).

Brief summaries of research conducted by the British Empire Cancer Campaign Research Laboratory, the Department of Pharmacy, and the Department of Chemistry are presented. (C.O.)

2707 OXFORD UNIVERSITY CANCER RESEARCH COMMITTEE. British Empire Cancer Campaign for Research., Annu. Rep., 240-5(1968).

Brief summaries of research conducted by the Cell Biology Unit, the Department of Biochemistry, the Laboratory of Clinical Cytology, the Department of Surgery, and the Department of Clinical Biochemistry are presented. (C.O.)

2708 THE BIRMINGHAM BRANCH OF THE BRITISH EMPIRE CANCER CAMPAIGN FOR RESEARCH. British Empire Cancer Campaign for Research., Annu. Rep., 246-58(1968).

Brief summaries of research conducted by the various branches of the project are presented. Included are reports of the Department of Pathology (chemical carcinogenesis and immunological studies), the Department of Biochemistry, the Department of Microbiology, the Department of Chemistry, the Department of Obstetrics and Gynecology, and the Department of Radiotherapy. (C.O.)

2709 NORTH OF ENGLAND COUNCIL OF THE BRITISH EMPIRE CANCER CAMPAIGN FOR RESEARCH. British Empire Cancer Campaign for Research., Annu. Rep., 259-70(1968).

Brief summaries of research conducted by the Cancer Research Unit, the Department of Microbiology (Cancer Research Section), the Department of Medicine, the Department of Pathology, the Department of Chemistry and the Department of Urology are presented. (C.O.)

2710 CHRISTIE HOSPITAL AND HOLT RADIUM INSTITUTE, MANCHESTER. British Empire Cancer Campaign for Research., Annu. Rep., 292-335(1968).

Brief summaries of research conducted are presented. The Paterson Laboratories reports include research in physics, radiation chemistry, radiobiology, biochemistry, chemotherapy and carcinogenesis, cell culture, cytogenetics, and clinical studies. (C.O.)

2711 THE ONTARIO CANCER TREATMENT AND RESEARCH FOUNDATION. British Empire Cancer Campaign for Research., Annu. Rep., 373-4(1968).

An outline is presented of the various research projects and

the institutions at which they are being conducted. Included is a project on fractionated uv radiation effects on cultured mammalian cells. A program on mammography education is also mentioned. (C.O.)

Protective Substances

Refer also to abstract 2840.

2712 (BNL–13981) REOXYGENATION AND ITS POTENTIAL ROLE IN RADIOTHERAPY. Elkind, M. M. (Brookhaven National Lab., Upton, N. Y.). [1969]. 61p. (CONF-690915–2). Dep. CFSTI.

From Proceedings on Time and Dose Relationships in Radiation Biology, Carmel, Calif.

The radiobiological basis for the choice of treatment times when high LET radiation in the form of fast neutrons is used for the treatment of deep-seated tumors is discussed. It is pointed out that the evidence indicates that most solid tumors contain significant numbers of hypoxic but still viable cells. A reduced oxygen enhancement ratio (OER) has been observed in single cell systems exposed to high LET when compared with low LET radiation. Data are reviewed from studies on the survival of tumor cells in cultures, experimental animals, human tumor biopsy specimens, and clinical trials following irradiation under the influence of air and nitrogen. The data indicate an effect caused by reoxygenation of the neoplastic cells. The influence of other factors, including cell age and stage of the cell cycle, on the reoxygenation of neoplastic cells are discussed. It is concluded that increasing the time intervals between fractionated doses of high LET radiation to allow for reoxygenation of neoplastic cells will improve the therapeutic value of irradiation by enhancing the degree of damage in tumors when compared with damage in normal cells. (C.H.)

2713 A CORRELATION BETWEEN THE ABILITY TO WITHSTAND HIGH TEMPERATURES AND RADIORESISTANCE IN DROSOPHILA MELANOGASTER. Parsons, P. A. (La Trobe Univ., Victoria, Australia). Experientia, 25: 1000–1 (Sept. 15, 1969).

Strains of Drosophila melanogaster were exposed to ^{60}Co γ radiation. The correlation between high temperature and radioresistance was investigated. (H.B.G.)

2714 MODIFICATIONS WITH CHELATING AGENTS OF THE EFFECTS OF γ-RAY FRACTIONATED EXPOSURES ON CHROMOSOME ABERRATIONS. Moutschen-Dahmen, J.; Moutschen-Dahmen, M.; Gilot-Delhalle, J. (Univ., Liege). Experientia, 25: 998-1000(Sept. 15, 1969).

Seeds of Nigella damascena were exposed to fractionated doses of ^{60}Co γ radiation. The effects of various chelating agents on radioinduced chromosome aberrations were investigated. (H.B.G.)

2715 COMBINED EFFECT OF X-IRRADIATION AND 5-FLUOROURACIL ON EHRLICH ASCITES TUMOR IN VIVO. Hasegawa, Masahide (Kyoto Prefectural Univ. of Medicine). Kyoto Furitsu Ika Daigaku Zasshi, 78: 359-68(June 1969). (In Japanese).

The combined effect of 5-fluorouracil (5-FU) and ionizing radiation on the reproductive integrity of mouse Ehrlich ascites tumor (E.a.t.) cells was studied in vivo. The mice carrying four day old E.a.t. cells in the peritoneal cavity received single injections of 5-FU at 0.004, 0.02, or 0.15 μg per gram of body weight intraperitoneally. Whole-body irradiation of the animals was done 1 hr after the drug administration. The treated E.a.t. cells were transplanted intraperitoneally into fresh recipient animals immediately after irradiation and surviving cells were allowed to reproduce for four days. Survival rate was calculated as a ratio of the growth fraction of treated cells to that of nontreated cells (control) in the cavity at four days. Surviving fractions plotted on a log-linear scale indicate that 5-FU does not enhance the lethal effect of radiation at the concentrations of 0.004 and 0.02 μg per gram of body weight, although it is slightly cytotoxic even at the concentrations of 0.15 μg per gram of body weight. Therefore it might be concluded that the effect of 5-FU was rather additive than sensitizing in this animal-tumor system. To test the effectiveness of fractionated doses of 5-FU, 0.15 μg per gram of body weight of the agent were divided into three injections given at 5 hr intervals. The additive effect of the agent was demonstrated and the divided administrations were less cytotoxic than the single injection of the same amount of 5-FU. In some papers published, 5-FU was reported as a radiation-sensitizer while in others, including this study, it has failed to show a sensitizing effect. Therefore, the mode of the combined action of ionizing radiation and 5-FU is discussed. (NSA of Japan)

2716 ACTION SPECTRUM FOR A DNA-PHOTOREACTIVATING ENZYME ISOLATED FROM HIGHER PLANTS. Saito, N.; Werbin, H. (South West Centre for Advanced Studies, Dallas). Radiat. Bot., 9: 421–4(Oct. 1969).

It is thought that in plants exposed daily to sunlight there must be efficient mechanisms to protect against or to repair far-UV damage to DNA. One such repair mechanism requiring light is photoreactivation or the restoration of biological activity of a far-U/V irradiated organism by light of a wavelength longer than that causing inactivation. Convincing evidence was found for the presence of a DNA-photoreactivating enzyme in cell free extracts of some higher plants. Some attempts are described to concentrate an enzyme from bean sprouts by ammonium sulphate precipitation and gel filtration chromatography, together with studies of its photoreactivating properties. (UK)

2717 RELATIONSHIP OF THE RADIOPROTECTIVE EFFECTIVENESS OF BETA-AMINOETHYLISOTHIURONE ON RADIATION DOSE. Vishevskaya, S. S. Izv. Akad. Nauk Kaz. SSR, Ser. Biol. Nauk, No. 3, 82-6(1968). (In Russian).

This study compares the effectiveness of the bromohydrate of 2-aminoethylisothiurone (AET) in decreasing the mortality of mice and in lessening bone marrow destruction after x irradiation in different doses. Experiments were carried out on mice of strain BALB/C, irradiated in doses of 100, 300, 600, and 1000 R with intensity 200 kV at 33 R/min. AET (9 tc 10 mg in 0.5 ml H_2O) was introduced subcutaneously 7 to 15 min before irradiation. The effect of radiation and AET on survival and length of life of animals was evaluated 30 days after irradiation. To determine destruction of bone marrow cells, mice were killed 6, 12, 24, 48, and 72 hr after irradiation. Bone marrow removed from the femoral bone was suspended in 5 ml 3% acetic acid solution. The total quantity of nucleated cells was computed in a Goryayev chamber. Six to ten animals were used in each of the studies. All mice, protected and unprotected, survived radiation doses of 100 and 300 R. Unprotected mice had a mortality of 100% with dose of 600 R, while survival was increased to 40% in protected mice. The average life span was also increased. With a dose of 1000 R all animals perished. The number of nucleated bone-marrow cells in unprotected animals was decreased. Protected mice irradiated with doses of 100 to 300 R showed an increase in the quantity of karyocytes starting with the 2nd day. With a dose of 600 R the protective influence of AET on the number of viable cells in the hip bone was observed after 6 hr, and with a dose of 1000 R after 2 days, although its effectiveness was decreased with this dose. The portion of protected cells reached a maximum with a dose of 600 R, and the coefficient of protection decreased with both an increase and a decrease of irradiation. (JPRS)

2718 A SEARCH FOR COMPOUNDS PROTECTING AGAINST RADIATION. XI. STUDIES ON ABSORPTION, DISTRIBUTION, AND EXCRETION OF BUNTE'S SALT LABELED WITH RADIOISOTOPE SULFUR (SB-^{35}S). Tulecki, Jerzy; Radola, Przemyslaw (Akademia Medyczna, Poznan, Poland). Diss. Pharm. Pharmacol., 19: 639-46(1967). (In Polish).

The Na salt of S-(1-carboenthoxybenzimidazolyl-2-methyl)-thiosulfuric acid labeled with radiosulfur (^{35}S) was synthesized, and proof was obtained that isotope exchange between sulfur atoms does not occur in the compound. The dynamics of absorption, distribution, rate, and channels of excretion of the compound were studied in mice. SB-^{35}S was injected intraperitoneally and into the stomach of mice in doses of 0.3 mg/g. After 10, 20, 40, 80, 160, 320, 540, 1280, and 2560 min radioactivity was measured in the blood, liver, spleen, kidneys, lungs, brain, heart muscle, skeletal muscle, stomach, small intestine, large intestine, and skin. Organs and tissues particularly sensitive to ionizing radiation showed selective properties in relation to the studied compound. Excretion of the compound from the body was studied by determining radioactivity in the urine and stools. Urinary excretion was much faster and more intensive than in the stools, irrespective of the route of administration. The first (I), second (II), and third (III) of the biologic half-life periods after intraperitoneal injection was 300 min, and after intragastric administration the I and II half-cycle was 600 min. The experiments revealed the optimal conditions for protection against radiation, using this compound. (BBB)

2719 MECHANISMS OF INHIBITION OF PYRIMIDINE DIMER FORMATION IN DEOXYRIBONUCLEIC ACID BY ACRIDINE DYES. Sutherland, B. M.; Sutherland, J. C. (Walter Reed Army Inst. of Research, Washington, D. C.). Biophys. J., 9: 292-302 (Mar. 1969).

The uv-induced formation of cyclobutyl pyrimidine dimers in Escherichia coli DNA in vitro was investigated in terms of the mechanism of inhibition by acridine dyes, the effect of dimer yield of specific singlet and triplet quenchers, and the mechanism of dimer formation. The DNA of E. coli 15 T$^-$ was labeled by

growing the cells in medium containing 1 mCi of thymidine-^{3}H. In the presence of proflavine and acridine orange the samples were exposed to 254-nm radiation from a low pressure mercury lamp. The dose delivered to the DNA was 4×10^4 erg mm^{-2}. Results indicated that energy transfer is important in dimer reduction by acridines, that this transfer occurs from the singlet (S_1) of DNA, and that at room temperature triplet quenchers do not reduce dimer yield in DNA. Neither paramagnetic ions (Ni^{++}) nor diamagnetic ions (Mg^{++}) affected dimer yield. These results implied that energy transfer from a singlet of DNA is responsible for dimer inhibition by acridines. The observed effective distance of 12 base pairs for dimer prevention agreed with the effective energy transfer length of 10 to 20 base pairs found from sensitized fluorescence of acridine orange. Acetone, which can quench the singlets, but not the triplets, of DNA, also reduced dimer yield. The results suggest that only singlets are energetic precursors of cyclobutyl pyrimidine dimers in DNA, and that energy transfer from singlets of DNA to acridine singlets inhibits dimer formation. (BBB)

2720 EFFECT OF SMALL DOSES OF SYNGENEIC BONE MARROW ON THE 30- AND 90-DAY LD_{50} OF X-IRRADIATED MICE. Doherty, David G.; Smith, L. H. (Oak Ridge National Lab., Tenn.). Radiat. Res., 40: 85-92(Oct. 1969).

The effects of very small doses of syngeneic bone marrow cells on 30- and 90-day survival of x-irradiated female (C57BL/Cum ♀ × C3H/Anf ♂)F_1 mice were studied, principally in the LD_{10}–LD_{100} range. As few as 0.01×10^6 cells improved survival of mice exposed to an LD_{100} or less, and a smaller cell dose was required to obtain good survival at mid-lethal exposures than at or above the LD_{100}. The data, together with previous results, indicate a triphasic response of the $LD_{50(30)}$ to the dose of syngeneic marrow cells. The $LD_{50(90)}$ and $LD_{50(30)}$ values are essentially the same, except for mice exposed to 1100, 1150, and 1200 R. In these groups 90-day survival percentages were about one-half those scored at 30 days. It was also found that slopes of survival curves for mice treated with marrow were about one-half those for x-ray control mice, implying that injected cells are more efficient at repopulation than host cells that survive exposures approaching LD_{100}. (auth)

2721 RADIOPROTECTIVE EFFECT OF HYDROGEN SULPHIDE IN DROSOPHILA MELANOGASTER. Matter, B. E.; Wuergler, F. E.; Ulrich, H. (Swiss Federal Inst. of Tech., Zurich). Int. J. Radiat. Biol., 15: 557-62(1969).

If Drosophila melanogaster eggs are irradiated in the presence of H_2S, the x-radioinduced embryonic mortality is reduced. Since H_2S is a radiomimetic substance in eggs of Drosophila, it could be that it kills selectively the radiosensitive nuclear division stages, after which a radioprotective effect would be merely simulated. Experiments were designed to distinguish between such an effect and true radioprotection. The data presented indicate that H_2S-induced selective cell-killing does not modify the effect of x rays to an extent detectable experimentally. Therefore it is concluded that H_2S exhibits a true radioprotective effect in Drosophila eggs. (auth)

Radiation Sickness and Injuries

2722 MORPHOLOGICAL AND CERTAIN HISTOCHEMICAL CHANGES OF LIVER OF IRRADIATED RATS UNDER THE INFLUENCE OF PREPARATION OF IRON (Fe-H-2). Shukurov, A. K.; Vysotskaya, L. A.; Alimov, R. A. (All-Union Scientific-Research Inst. of Roentgenology, Radiology, and Oncology, Tashkent). Uzb. Biol. Zh., No. 5, 69-70(1968). (In Russian).

The influence of the iron preparation Fe-H-2 on the morphological and histochemical indexes of liver of irradiated white Wistar rats of the same sex was studied in rats weighing 80 to 120 g. The animals were subjected to a single whole-body x irradiation dose of 700 R on a THX-250 apparatus with an ntensity of 20 kV; the current rate was 10 ma, filter 0.5 Cu + 1 mM Al, skin-focal distance 30 cm, and the dose rate was 139 R/min. Under the influence of Fe-H-2, administered to irradiated rats, the structure of the hepatic parenchyma was almost restored. The content of DNA, RNA, and glycogen approached the indexes of healthy rats. Thus, the Fe-H-2 that was administered to irradiated animals accelerated the recovery processes and promoted the normalization of the exchangeable processes in liver. (tr-auth)

2723 THEORETICAL BACKGROUND FOR THE FACILITATION OF RECOVERY FROM ACUTE RADIATION SICKNESS. Hernadi, Ferenc (Univ. of Debrecen, Hungary). Orv. Hetil., 110: 1369-73(June 15, 1969). (In Hungarian).

Following whole-body irradiation with 200 to 800 R, the irradiation death of mammals is caused primarily by the destruction of bone marrow and intestinal mucosa cells. After radiation damage, a possibility of restitution exists for the cell populations mentioned. In the case of bone marrow, restitution is initiated from the so-called primordial cells and takes place in two phases: phase one is at the cell level, phase two is at the cell population level. In theory, restitution at the cell level could be facilitated with SH-containing compounds (so-called physicochemical repair) with inductors of enzymes acting on the removal and resynthetization of the damaged parts of macromolecules, with precursors of the damaged macromolecules (biochemical repair) and with allogenous or isogenous DNA (bypass). Restitution at the cell population level could be supported by means of agents that increase the rate of restitution by the damaged primordial cell populations themselves or which increase the number of differentiating cells. Until satisfactory restitution is achieved at the cellular and cell populational level, a two-fold pharmacological task must be carried out: substitution and protective therapy must be applied. (61 references) (JPRS)

2724 CHEMICAL PROTECTION AGAINST EARLY SYMPTOMS OF EXPERIMENTAL RADIATION SICKNESS. Andras, Santha. Honvedorvos,; 21: 188-98(Apr-Jun 1969). (In Hungarian).

The effects of antiemetic drugs on the emetic stages of radiation sickness were tested using pigeons and frogs. The antiemetic drugs were also used to treat other symptoms of radiation sickness (adenomas and reduced work fitness) in mice and rats. The results confirmed the antiemetic effects of phenothiazines. However, it was also found that the derivatives of phenothiazine lowered the work fitness and effected the incidence of adenomas due to their tranquilizing effects and therefore did not prevent the early symptoms of radiation sickness. Metoclopramide proved to be a more satisfactory antiemetic without any side effects on spontaneous activities. It also reduced the incidence of adenomas and alleviated reduced working fitness. (R.V.J.)

2725 COMBINED THERAPY OF RADIATION INJURIES. Berkutov, A. N. Honvedorvos; 21: 151-5(Apr-Jun 1969). (In Hungarian).

A brief description is given of the effects of treatment of radiation injuries with combinations of antibiotics, vitamins, and oral or injected pharmaceuticals. (R.V.J.)

2726 NEOTLOZHNAYA POMOSHCH' PRI OSTRYKH PORAZHENIYAKH RADIOAKTIVNYMI VESHCHESTVAMI. (First Aid of Acute Injuries by Radioactive Substances). Borisov, V. P.; Zhuraviev, V. F.; Ivanov, V. A.; Severin, S. F. Moscow, Atomizdat, 1968. 207p.

The problems of first aid in acute injuries by radioactive substances are discussed. Information concerning radioactive substances as the sources of radiation injuries and the peculiarities of their effects on the body are included. Data are also given concerning the use of radioactive isotopes in medicine and the methods of their discovery are described. The clinical picture of acute and chronic radiation sickness is also given. Experiences concerning the prophylaxis and treatment of radiation disease caused by both external and internal sources of radiation are presented. Along with recommendations concerning the medical treatment of radiation injuries is given brief information concerning the conducting of sanitary treatment, disinfection of skin and mucous membranes. A table of antidotes and measures to be used in rendering first aid in cases of acute poisoning by radioactive substances, worked out on the basis of investigations of domestic and foreign specialists in the field of toxicology of radioactive substances and by experimental treatment of radiation injuries is also included. The book was designed for use by a wide range of physicians, therapists, radiobiologists, toxicologists, sanitorium workers and nurses, and first aid stations. (tr-auth)

2727 ON THE EFFECT OF BONE MARROW AND SPLEEN CELL INFUSION ON TUMOR GROWTH AND IRRADIATION DAMAGE IN RATS. von Metzler, Alexandra (Institut fuer Milchvitaminierung, Frankfurt am Main). Z. Krebsforsch., 72: 312-20(July 7, 1969). (In German).

Rats of different genetic strains (Sprague–Dawley, BD II, and Wistar) were x-irradiated with 700 R and then infused with homologous bone marrow or bone marrow plus spleen cells. The rate of survival differed with the strain. Animals of the same strain with tumors, x-irradiated and treated in the same manner, reacted more sensitively than animals of the control group, although the x-ray treatment itself did not shorten their life span. Lower x-ray doses plus infusions of bone marrow and spleen cells improved the survival rate, although not significantly. The survival rate was significantly improved after infusion of spleen cells from rats pretreated with lipopolysaccharide and with lower x-ray doses. On the average, the survival rate was doubled (in

some animals four to five times longer than normal) and, accordingly, tumor growth was retarded. (BBB)

Radiodiagnosis

Refer also to abstracts 2451, 2455, 2559, 2660, 2669, 2676, 2822, and 2828.

2728 (NYO-4039-1, pp 79-83) USE OF RADIONUCLIDES IN VETERINARY MEDICINE. Kallfelz, F. A. (New York State Veterinary Coll., Ithaca).

Brief summaries of applications of radioisotopes in veterinary practice are presented. These include determination of total serum thyroxine in the dog by competitive protein binding of labeled thyroxine; comparison of the ^{125}I-T_3 and ^{125}I-T_4 tests in the diagnosis of thyroid gland function in the dog; estimation of parameters of thyroid function in domestic animals; investigation of thyroxine binding properties of canine serum proteins; labeled fat absorption as a diagnostic tool; the radioisotope renogram; and bone calcium accretion as a function of age in the beagle dog as determined by a whole-body counting technique. (C.O.)

2729 ^{113m}In RADIOPHARMACEUTICALS FOR MULTIPURPOSE IMAGING. Burdine, John A. Jr. (Baylor Coll., Houston, Tex.). Radiology, 93: 605-10(Sept. 1969).

The gamma-emitting radionuclide ^{113m}In may be incorporated as the radioactive label for a series of compounds with which the brain, kidneys, lungs, liver-spleen, and blood pools can be imaged. Less than a dozen basic reagents are necessary for producing this spectrum of radiopharmaceuticals. Because of the extremely short half-life of 1.7 hr, relatively large patient doses are permitted within the limits of radiation safety. The high photon yields obtained result in better image statistics and quality. Although facilities for pyrogen testing and radiochemical formulation are necessary when using indium at present, it is possible that radionuclide kits will be supplied by commercial manufacturers in the future so that specific compounds can be formulated as the need arises. Thus, both small and large volume laboratories would have short-lived compounds available for clinical use. (auth)

2730 SIMPLIFIED DUAL-PROBE THYROID-UPTAKE SYSTEM. Mantel, Joseph; Ruskin, Robert L.; Corrigan, Kenneth E. (Wayne State Univ., Detroit). Radiology, 93: 687-91(Sept. 1969).

Design features of a dual-probe radioisotope scintillation scanner for use in thyroid uptake studies are described. The probes are fixed at 90° angles to each other with the crystals positioned close to the patient's neck, and are maintained in position by two Al spacers mounted on a base with wheels. (C.H.)

2731 RADIONUCLEAR (^{75}Se) IDENTIFICATION OF TUMOR IN CHILDREN WITH NEUROBLASTOMA. D'Angio, G. J.; Loken, M.; Nesbit, M. (Univ. of Minnesota, Minneapolis). Radiology, 93: 615-17(Sept. 1969).

An attempt was made to exploit for diagnostic purposes the ability of neuroblastoma cells to synthesize cystathionine. Selenium-75 labeled methionine was given to four patients with known metastatic neuroblastoma. Localization within the tumor was confirmed on scans obtained 3 to 6 hr after the injection of the radionuclide in three of the patients. Two of the patients showed incorporation of radioisotope into the tumor specimen taken at surgery. (auth)

2732 THE INVERSE PROBLEM OF RADIOISOTOPE DIAGNOSIS: A COMPUTATIONAL METHOD FOR DETERMINING THE LOCATION AND SIZE OF TUMORS. Kaplan, S.; McNabb, A.; Trujillo, D.; Siemsen, J. K. (Univ. of Southern California, Los Angeles). Math. Biosci., 5: No. 1-2, 39-55(Aug. 1969).

The problem of finding tumors through interpretation of radioisotope scan data is discussed. The approach proposed includes an experimental measurement of the appropriate Green's function and some mathematical methods for solving the resulting inverse problem. The methods are illustrated by numerical examples. Pitfalls in the approach are pointed out and devices for overcoming them discussed. (auth)

2733 ^{99m}Tc PERTECHNETATE ANGIOCARDIOGRAPHY IN THE DIAGNOSIS OF SUPERIOR MEDIASTINAL MASSES AND PERICARDIAL EFFUSIONS. Bonte, Frederick J.; Christensen, Edward E.; Curry III, Thomas S. (Univ. of Texas, Dallas). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 107: 404-12(Oct. 1969).

With progress in instrumentation and tracer pharmacology, the blood pool scan has evolved in the radionuclide angiocardiogram with its dynamic and static phases. When applied to the differential diagnosis of superior mediastinal lesions, ^{99m}Tc-sodium pertechnetate is the tracer of choice, because of its proclivity for localizing in thyroid tissue. During the dynamic phase of the study, best performed with a camera device, it is possible to identify displacement and obstruction of mediastinal great veins, and if the study is extended for 30 to 60 seconds, pericardial effusion may be identified with a good degree of security. The static phase of radionuclide angiocardiography is best visualized with a large-crystal rectilinear scanner. The static phase, and its matching roentgenogram, will usually enable the examiner to decide whether a superior mediastinal mass is, or is not, of thyroid origin, and further, to differentiate between masses that contain large blood pools, such as aneurysms, and those that do not, such as solid tumors. Radionuclide angiocardiography may be performed rapidly and safely, and constitutes one of the best primary examinations that can be offered in cases of mediastinal tumors of unknown origin. The dynamic phase of this study may well be the method of choice in detection of pericardial effusions of any origin. (auth)

2734 UNEVEN DISTRIBUTION OF PULMONARY BLOOD FLOW BETWEEN LEFT AND RIGHT LUNGS IN ISOLATED VALVULAR PULMONARY STENOSIS. Chen, James T. T.; Robinson, Arvin E.; Goodrich, Jack K.; Lester, Richard G. (Duke Univ., Durham, N. C.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 107: 343-50(Oct. 1969).

Seven patients without cardiac abnormality and eight patients with isolated pulmonary stenosis were studied by chest roentgenographic analysis, cardiac catheterization with angiocardiography, and radionuclide (^{131}I MAA) lung scanning. Five patients with valvular stenosis showed an uneven distribution of pulmonary blood flow between the left and right lungs, in favor of the left. This was a reversal of the normal pattern. Two patients with pure pulmonary infundibular stenosis and one patient with valvular pulmonary stenosis with secondary infundibular hypertrophy showed either normal pulmonary vasculature or shift of flow from the right to left that could be appreciated only by the quantitative data in radionuclide lung studies. Roentgenographic analysis plus lung scanning appears to be promising in the differentiation of valvular pulmonary stenosis from other types of pulmonary stenosis and the secundum type of atrial septal defect. It should also be valuable in ascertaining the therapeutic results of surgery in valvular pulmonary stenosis. (auth)

2735 LUNG SCANNING IN THE ASSESSMENT OF RESPIRATORY DISEASE IN CHILDREN. Pendarvis, Ben C.; Swischuk, Leonard E. (Univ. of Oklahoma, Oklahoma City). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 107: 313-21(Oct. 1969).

Cases of seven children with chronic respiratory diseases are reported and the pulmonary roentgenographic, arteriographic, bronchographic, and scanning findings correlated. The scanning findings are specifically assessed and it is concluded that the information obtained complemented and enhanced other available data. (auth)

2736 COMPARISON BETWEEN THE CLEARANCE OF ^{125}I-HIPPURAN AND PAI. Mombelli, L.; Roncari, G.; Fidanza, M. A.; Comotti, L. (Univ., Milan). Radiol. Med., 55: 761-71(Aug. 1969). (In Italian).

^{125}I-Hippuran and paraminohippuran (PAI) clearance were determined simultaneously in the same subjects by means of a constant infusion technique; the free radioiodine in the injected Hippuran preparation was also checked. A 5% difference in favor of PAI clearance was found to be highly significant on statistical analysis. It is shown that this difference can be explained in quantitative terms by the presence of free radioiodine in ^{125}I-Hippuran solutions; the view that renal behavior differs with respect to the two substances is untenable. It is suggested that, from the practical point of view, the determination of renal plasma flow for clinical and diagnostic purposes with ^{125}I-labeled Hippuran be used in place of the PAI clearance method. The difference between the values given by the two techniques is very slight and can, if required, be checked on the basis of the free radioiodine present in the Hippuran preparation. (auth)

2737 PSEUDO-TUMORAL FOCALIZED HYPER-RADIOACTIVITY IN VASCULAR LESIONS OF THE BRAIN. Dalbuono, S. (Univ., Strasbourg. Ospedale Maggiole, Bologna). Radiol. Med., 55: 755-60(Aug. 1969). (In Italian).

Ten cases of vascular disease of the brain were studied with ^{197}Hg-labeled Neohydrin. The results are compared with those obtained with RISA and discussed on the basis of the present literature. (auth)

2738 SCINTIGRAPHIC PATTERNS OF DIFFUSION OF COLLOIDAL ^{198}Au IN STUDIES ON LYMPHATICS OF THE HEAD AND NECK IN CANCER PATHOLOGY. de Campora, E.; Senin, U.; Nardi, S. (Univ., Perugia, Italy). Nunt. Radiol., 34: 763-76(Aug. 1968). (In Italian).

Application of colloidal ^{198}Au in scanning the lymphatic system of the head and neck are discussed. Emphasis is placed on the interpretation of the scan data for the diagnosis of neoplasms of the lymph system. (C.H.)

2739 SCINTIGRAPHIC INDICATIONS FOR LYMPHATICS OF THE NOSE WITH COLLOIDAL ^{198}Au. Senin, U.; de Campora, E.; Nardi, S. (Univ., Perugia, Italy). Nunt. Radiol., 34: 817-29(Aug. 1968). (In Italian).

The use of scanning with ^{198}Au colloids for the localization of diseased nodes in the lymph system of the nasopharyngeal region in man was evaluated. It was concluded that the difficulties encountered preclude obtaining meaningful diagnostic information from scan data for this area. (C.H.)

2740 CONSIDERATION OF COMPARATIVE POSITIONS OF HEPATIC SCINTIGRAPHY AND SPLENOPORTOGRAPHY IN DIAGNOSIS OF HYDATID CYST OF THE LIVER. Cavallo, V.; Fresu, I.; Taschieri, A. M. (Univ., Sassari, Italy). Nunt. Radiol., 34: 481-502(June 1968). (In Italian).

Five cases of hydatid cyst of the liver examined by the colloidal radioactive gold scintigraphy and by the transparietal splenoportography are presented. The semeiological signs given by the two examinations are emphasized. It is concluded that scintigraphy presents the method of choice, whereas the splenoportography is very useful for morphology studies. (auth)

2741 SUMMARY OF DIAGNOSTIC X-RAY STATISTICS RELATING FACILITIES, EQUIPMENT, AND PERSONNEL BY HEALING ARTS PROFESSIONS. Fess, Lawrence R. (Bureau of Radiological Health, Rockville, Md.). Radiol. Health Data Rep., 10: 379-80(Sept. 1969).

Data were derived, based primarily on the collection of Radiation Protection Survey Reports from States, that provide estimates of the numbers of x-ray machines and of machine operators and practitioners who are involved with the use of x rays in various types of practice. The statistical data, which are presented in tabular form, summarize the estimated numbers of healing arts practitioners and diagnostic x-ray facilities, equipment, and personnel by healing arts profession in the United States as of June 1965. (E.R.B.)

2742 CAUSES OF ERROR IN THE EVALUATION OF THYROID FUNCTION IN RELATION TO THE USE OF ^{131}I ADMINISTERED IN GELATIN CAPSULES. Peyrin, J.-O.; Espinasse, P.; Berger, M. (CNRS, Lyon). Lyon Med., 218: 1509-20(Dec. 10, 1967). (In French).

An error was found in the technique employing ^{131}I to test thyroid function which was traced to interaction of the ^{131}I with the gelatin of the capsules in which the radioisotope was administered. The capsules, containing doses of 20 or 50 μCi, were supplied by the Commissariat Francais a l'Energie Atomique. Markedly different levels of serum and urinary radioactivity were found between two groups of euthyroid subjects who were tested with ^{131}I in gelatin capsules and with a thiosulfate solution of ^{131}I. Thus, the 2-hr serum level of organic iodide was 2.6% (conversion index) in the group given ^{131}I in thiosulfate solution compared with 29.3% in those receiving it in gelatin capsules. Chromatographic studies revealed the presence of an organic ^{131}I compound in the capsule preparation used for the test. This compound evidently enters the blood and accounts for the erroneously elevated level of organically bound ^{131}I that is obtained. This error is much more pronounced in the 2-hr value than in the 24-hr value. (BBB)

2743 THE SIGNIFICANCE OF ANGIOSCINTIGRAPHY IN NEURORADIOLOGY. Huber, P.; Roesler, H. (Strahleninstitut, Inselspital, Bern). Schweiz. Med. Wochensch., 99: 757-63(May 24, 1969). (In German).

The use of ^{99m}Tc in diagnosis of cerebral lesions is described, and two central nervous system diagnostic methods requiring puncture of an artery (angiography and ^{99m}Tc angioscintigraphy) are compared on the basis of 126 examinations. The radioisotope method depends upon the localization of ^{99m}Tc-labeled macroaggregated human serum albumin in the cerebral lesion. These macroaggregates (~10 μ dia) accumulate in small blood vessels as emboli, enabling visualization of the capillary network of the tumor or other highly vascularized process. The results showed that angiography provides more accurate information than angioscintigraphy in most cases, especially on the nature of the pathologic process. Therefore, angioscintigraphy should be performed not as a single diagnostic procedure but in combination with angiography. Combination of the two methods can be useful in cases where angiography alone fails to afford precise information. In one case, described and illustrated in detail, the effect of radiotherapy on cerebral metastases was followed by ^{99m}Tc scintigraphy. Regression of the radioisotope-localizing area was seen postirradiation and after antiedema therapy. (BBB)

2744 PHOTOSCANNING OF THE PLACENTA WITH ^{99m}Tc ALBUMIN. Frederiksen, P. Buechler; Moestrup, J. K.; Munk, J.; Madsen, W. Sondergaard (Odense Hospital, Denmark). Nord. Med., 81: 46-50(Jan. 9, 1969). (In Danish).

The use of ^{24}Na, ^{131}I, ^{132}I, ^{51}Cr, and ^{99m}Tc for placental scanning is considered, and on the basis of safety features it was concluded that ^{99m}Tc is superior to the other isotopes. Preparation of the isotope from a ^{99}Mo generator to obtain a solution of ^{99m}Tc containing 1 to 2 mCi/ml is described, as well as the scanning equipment used. Doses of about 1 mCi provided counts over the placenta of 6000 to 10,000 cpm. Photoscanning of the placenta with ^{99m}Tc-labeled albumin was performed in 23 patients. In all cases the placenta was satisfactorily displayed. The results indicated that the method is a valuable aid to differential diagnosis in pregnant women with third-trimester bleeding and before performing amniocentesis. The radiation dose to the fetus is much lower than that in roentgenologic methods. (BBB)

2745 IMPROVEMENT IN NEW YORK CITY X-RAY INSTALLATIONS DURING THE FIRST SEVEN YEARS OF A RADIATION CONTROL PROGRAM. Blatz, Hanson; Lynch, Daniel E. (New York City Dept. of Health). Radiol. Health Data Rep., 10: 89-92(Mar. 1969).

The percentage of private medical radiographic units in New York City free from described deficiencies, increased from 8 to 73% between 1959 and 1966; for dental radiographic units the increase was from 47 to 89%. The percentage of medical radiographic units considered to have adequate x-ray beam filtration increased from 75 to 95% in this period; for fluoroscopes the improvement was from 81 to 94% and for dental machines, from 66 to 96%. Also during this period, the percentage of machines possessing adequate beam limitation increased as follows: for medical radiographic units, 34 to 90%; for fluoroscopic units, 40 to 83%; and for dental units, 73 to 94%. (auth)

2746 NEW SYSTEM OF SCINTIGRAPHY IN COLOR WITHOUT INERTIA OR CONSTANT TIME. Desgrez, A. (CEA, Orsay, France). J. Biol. Med. Nucl., 3: No. 11, 11-16(1968). (In French).

A method is described for producing color scans during radioisotope scintillaion scanning. The photographic recording device includes a rotating disc holding color filters connected to a photodiode to produce flashes of color at very short time intervals without interference by inertia. A schematic sketch of the system is included. (C.H.)

2747 AN APPROACH TO DEVELOPING ADRENAL-GLAND SCANNING. Nagai, T.; Solis, B. A.; Koh, C. S. (National Inst. of Radiological Sciences, Chiba, Japan). J. Nucl. Med., 9: 576-81(Nov. 1968).

Stigmasterol labeled with iodine-131 administered to mice selectively localized in the adrenal glands. Although the degree of localization was insufficient for actual clinical scanning, in two out of three patients with adrenal tumor there was good correlation between the preoperative scans and subsequent surgical findings. The search for a practical technique to scan the adrenal glands is being continued. (auth)

2748 SALIVARY-GLAND SCANNING WITH ^{99m}Tc. Enfors, B.; Lind, M.; Soederborg, B. (Soedersjukhuset, Stockholm). Acta Oto-laryngol., 67: 650-4(June 1969).

A scanning method is described that can be used routinely to visualize the salivary glands. The procedure requires about 15-min. Of the 60 subjects examined, only a few had symptoms of salivary-gland disease. In most cases, the examination was started with slow, intravenous injection of 1.0 mg of atropine sulfate. After about 1 min, ^{99m}Tc-pertechnetate was injected intravenously through the same cannula. The dose of ^{99m}Tc ranged from 1 to 6 mCi, generally 2.0 mCi. Scanning was started 15 min after injection of ^{99m}Tc. The standard dose (2.0 mCi of ^{99m}Tc) which gives a low exposure to total-body irradiation, proved sufficient to provide good, uniform recordings. If greater resolution is desired to permit a more detailed analysis, the dose can be raised to 6 mCi and the rate of scanning decreased. The degree of density of the records is dependent partly on the total quantity of ^{99m}Tc injected, and partly on the relative concentration of the isotope in the parenchyma of the salivary glands. The uptake in the glands may vary according to different functional and pathological states. In a few examinations of patients with symptoms of salivary-gland disease, records differing from those in healthy subjects were obtained. This scanning method may be useful in the evaluation of pathological conditions. (BBB)

Radiotherapy

Refer also to abstracts 2661, 2712, 2764, 2809, 2811, 2813, 2815–2819, and 2824–2827.

2749 MALIGNANT TUMORS OF THE OVARY MANAGED WITH POSTOPERATIVE MEGAVOLTAGE IRRADIATION. Delclos, Luis; Quinlan, Edward J. (Univ. of Texas, Houston). Radiology, 93: 659-63(Sept. 1969).

The histopathological grouping and initial degree of tumor extension are important for planning postoperative megavoltage irradiation of ovarian neoplasms but also of importance is the amount of residual disease left after the surgical procedure. Stages II and III patients should have as much tumor removed as possible followed by postoperative irradiation consisting of whole-abdominal irradiation plus additional treatment to the pelvis. When large tumor masses have been left, other modalities (chemotherapy or a combination of chemotherapy and irradiation) should be explored. (auth)

2750 MEGAVOLTAGE RADIATION THERAPY AND LYMPHANGIOGRAPHY IN OVARIAN CANCER. Hanks, Gerald E.; Bagshaw, Malcolm A. (Stanford Univ., Palo Alto, Calif.). Radiology, 93: 649-54(Sept. 1969).

In a series of 103 patients with untreated ovarian carcinoma, many were controlled by aggressive postoperative megavoltage radiation therapy. (Stage II, 82%; Stage III, 55%; Stage IV, 16%; overall, 42%.) In seven of 22 additional selected patients, lymphangiography was essential to proper staging and in the definition of treatment parameters. Complications in the liver and gastrointestinal tract following radiation therapy limited the dose used in some cases. (C.H.)

2751 SCATTERING FOIL DEVICE FOR HIGH-ENERGY ELECTRON-BEAM THERAPY. Okumura, Yutaka; Kitagawa, Toshio; Kitabatake, Takashi (Aichi Cancer Center, Nagoya, Japan). Radiology, 93: 667-70(Sept. 1969).

A scattering-foil device was evaluated, using high-energy electron-beam therapy with a betatron operation in the 4 to 31 MeV energy range. Desirable isodose curves were obtained, and the high-intensity portion of the 90% isodose curve was adjusted in position and width with a surrounding flat 70% isodose curve. This method simplified the setting up of treatments, avoided the formation of secondary radiation, and preserved a skin-sparing effect. It was found advantageous in the treatment of regionally invasive tumors in which a homogeneous field was less suitable. (auth)

2752 CHANGES IN THE TRANSVERSE CARDIAC DIAMETER FOLLOWING MEDIASTINAL IRRADIATION FOR HODGKIN'S DISEASE. Pierce, Robert H.; Hafermann, Mark D.; Kagan, A. Robert (National Inst. of Health, Bethesda, Md.). Radiology, 93: 619-24(Sept. 1969).

Out of a group of 87 patients irradiated for Hodgkin's disease, 19 (21%) showed radiographic evidence of pericardial effusions that are believed to secondary to irradiation. The anterior pericardium received a relatively high dose of radiation due to the nearly exclusive use of anterior portals in this series of patients. Patients with mediastinal and/or hilar disease demonstrated a greater incidence of pericardial effusions than those with radiographically negative mediastinums. A transient decrease in the transverse cardiac diameter (TCD) occurred regularly during large-field irradiation. This is believed to be due to a drop in blood volume accompanying a large weight loss. It is necessary for post-treatment radiographs to be compared with pretreatment radiographs for proper evaluation of upward trends in the TCD. The occurrence of pericardial effusion following mediastinal irradiation for malignant disease is a significant problem and deserves further study of incidence, mechanism, and treatment. It should, however, be placed in proper perspective, with the realization that many of these patients are given potentially curative treatment for malignant disease. (C.H.)

2753 (γ,n) REACTION INDUCED BY 26-MeV X RAYS OF BETATRON. Hisada, Kin-ichi; Matsudaira, Masamichi (Kanazawa Univ. Hospital, Japan). Radioisotopes (Tokyo), 18: 427-31 (Oct. 1969). (In Japanese).

In radiation therapy some radioactivity is produced in the body of patients and in the treatment bed. This activity is caused by (γ,n) nuclear reaction. Details of the radiocontamination induced by 26 MeV betatron x rays were examined from the standpoint of radiation protection. Main nuclides produced in the body by supervoltage x irradiation are ^{15}O and ^{11}C. If 20 cm thick portions of a human body are irradiated by 26 MeV x rays at a dose rate of 40 R/min and a field size of 10 by 10 cm, 150 μCi of ^{15}O and 5 μCi of ^{11}C are produced in the body. The activity is detected by scintillation camera. In the treatment bed, made either of wood or of acrylite, ^{15}O and ^{11}C also are produced by radiation. X ray dose rates produced by present day betatrons are not very high and the amounts of ^{15}O and ^{11}C causes no problems in radiation protection. In the future, however, contamination should be considered when supervoltage x rays of higher dose rate are used. (H.B.G.)

2754 REVIEW ON HUMAN LEUKEMIAS FOLLOWING RADIOTHERAPY IN JAPAN. Kitabatake, Takashi; Kurokawa, Shigeki (Niigata Univ., Japan). Acta Med. Biol. (Niigata), 17: No. 1, 1-8(June 1969).

From 1954 to 1966, 52 cases of leukemia that developed after therapeutic irradiation were reported in Japanese literature. Compared with leukemias seen among the general population, radioinduced leukemias were more frequent in the older age groups with a statistically significant difference. This analysis of Japanese cases did not support the widely believed theory that acute myeloid leukemias were more frequent among radiotherapeutic patients than among other exposed persons. The relationship between the radiation dose given and the length of the latent period was not clear. However, the length of the latent period showed an almost log-normal distribution as was seen in radiation cancers other than leukemias. (NSA of Japan)

2755 EXPERIMENTAL AND CLINICAL STUDIES ON THE EFFECTS OF LOCAL COOLING IRRADIATION. Watanabe, Muneo (Iwate Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 284-303(June 1969). (In Japanese).

Experimental and clinical studies were done for the purpose of improving the therapeutic ratio by cooling the skin with ice bags and dry ice, thereby lowering its sensitivity to irradiation. The results were as follows: After repeated irradiation to the skin of rabbit's thigh, keeping the skin temperature between 5° to 15°C, the skin reaction to irradiation was examined macro- and microscopically in comparison with a non-cooled area. The average x-ray dose on the cooled area that produced lamellar scales was 64% larger than for the non-cooled area, and histologically, the skin reaction to irradiation was markedly decreased. The oxygen tension of the subcutaneous tissue under cooling, when examined by means of an oxygen cathode, decreased to less than a fifth of that of the non-cooled area. This anoxic situation seems important in decreasing the sensitivity to irradiation. When these results were applied for therapeutic purposes, the cooling with irradiation proved to increase the tolerance dose of skin by 40 to 50% and allowed the use of massive doses of irradiation for deep therapy. (NSA of Japan) (TSS)

2756 RADIOTHERAPY IN GYNECOLOGICAL MALIGNANCY. Freeman, W. E. (United Birmingham Hospitals, Eng.). Brit. J. Hosp. Med., 2: 869-80(Apr. 1969).

Some radiobiological aspects of treatment of uterine cancer are reviewed. Important factors affecting radioinduced change, apart from physical ones such as dose and techniques ensuring uniform irradiation of tumor volume, include less easily definable ones such as the general condition of the patient, nutritional state, age, presence of infection, endocrine balance, and immune response. Also, individuals may respond differently to irradiation at different times and even at the same time for different sites. In addition, the size of the tumor, its macroscopic features, its histological type, and the state of the tumor bed all influence radioresponse. The oxygen effect in tumor radiosensitivity is discussed. Radiosensitivity is distinguished from radiocurability. A highly radiosensitive tumor is usually a poorly differentiated one, and although it may show dramatic response to treatment, often has spread too rapidly to be eradicated or has metastasized early. The more radiocurable tumors tend to have intermediate radiosensitivity. Attempts to assess or predict radiation response in the treatment of carcinoma of the cervix are examined, as are time-dose relation and RBE. The reaction to radiation increases with the volume of tissue treated, but the larger the volume, the less likelihood of achieving an adequate dose because of the reduction in tolerance. On the other hand, tolerance of normal tissues is improved by fractionation and prolonging the overall treatment time. This balance between the tumor-lethal dose and that compatible with recovery of normal tissues is the limiting factor in treatment. (BBB)

2757 CLINICAL OBSERVATIONS ON 62 CASES OF PAROTID TUMORS CURED WITH CESIUM THERAPY. Borghi, A.; D'-Ettorre, A.; Lentini, A. (Univ., Bologna). Nunt. Radiol., 34: 789-801(Aug. 1968). (In Italian).

Data are reviewed on 62 patients with malignant tumors of the parotid gland who were treated with γ radiation from a ^{137}Cs unit. Good results were observed five years following treatment with fractionated focal doses of 200 rad resulting in a total dose of 4,600 to 6,000 rad. The importance of using super-volt therapy for the treatment of parotid neoplasms to increase the rate of sur-

vival and reduce the side effects of the treatment is discussed. (C.H.)

2758 VARIATIONS IN THE ACTIVITY OF NONSPECIFIC ESTERASES DURING IRRADIATION OF SQUAMOUS CELL CARCINOMA OF THE UTERINE CERVIX. Thiery, M. (Univ. of Ghent); Willighagen, R. G. J. Gynaecologia, 168: 81-5 (1969).

Twenty-nine patients with squamous cell carcinoma of the cervix uteri were biopsied prior to and during irradiation as well as before and after each application of Ra, the total number of applications varying from 1 to 5. The localization and activity of nonspecific esterases were demonstrated by means of four substrates: α-naphthyl acetate, naphthol ASD acetate, 5-bromoindoxyl acetate, and 5-bromo-4-chloroindoxyl acetate. Comparison of neoplastic squamous cells before and during irradiation showed treatment to be accompanied by a tendency towards increased enzyme activity. Although noticeable with all the staining methods used, this tendency was most evident with 5-bromo-indoxylacetate as the substrate. In most cases the rise was gradual and progressive. Increases were most pronounced in dedifferentiated tumors. The difference was significant between grade I, II, and III tumors. Nonspecific esterase activity, in contradistinction to the other enzymes investigated (alkaline phosphatase, 5-nucleotidase, adenosinetriphosphatase, and glucose-6-phosphate dehydrogenase), seemed to be proportionate to the degree of differentiation of the tumor. It is suggested that the activity of nonspecific esterases be used to assess radiosensitivity of cervix carcinoma. (BBB)

2759 CONVENTIONAL AND RADIOISOTOPE LYMPHOGRAPHY IN CHRONIC LYMPHOID LEUKEMIA. Coeur, P.; Chassard, J. L.; Papillon, J.; Lahneche, B.; Verot, R.; Revol, L.; Croizat, P. (Centre L. Berard, Lyon). Nouv. Rev. Franc. Hematol., 9: 409-18 (May-June 1969). (In French).

The effects of lymphography with ^{131}I- and ^{32}P-labeled Lipiodol in 21 patients with chronic lymphoid leukemia were studied. Doses of 2 mCi ^{131}I and 4 mCi ^{32}P were used. The treatments were well tolerated and reduced the volume of the involved lymph nodes in 19 of the 21 cases. In 11 of these 21 patients the leukocytosis was also decreased. In eight cases the drop in circulating leukocytes was obtained without additional therapy. In the others, abdominal radiotherapy or chemotherapy was also used. In three cases the circulating leukocytes fell within 1 month from 128,000 to 65,000, from 80,000 to 33,000, and 60,000 to 40,000/mm^3, respectively. However, in one patient they rose from 36,000 to 170,000 during intralymphatic radioisotope treatment. In four cases swelling of the spleen was reduced, and in some the lymph node enlargement was diminished. Histologic studies revealed necrotic areas in the lymph nodes produced by the intralymphatic injection of ^{131}I- or ^{32}P-Lipiodol. (BBB)

2760 THE SIGNIFICANCE OF THE X-RAY DOSE ADMINISTERED PER UNIT OF TIME IN DERMATOLOGIC RADIOTHERAPY. Lozeron, H.; Maggiora, A.; Rossier, J.; Jadassohn, W. (Univ., Geneva). Dermatol. Wochenschr., 154: 537-40 (June 1968). (In German).

Effects of rate of administration of x irradiation doses on secondary rooting of Vicia faba equina and on epilation in guinea pigs were studied. The plants were irradiated with 400 R at dose rates of 82 or 20 R/min and the guinea pigs were given 1600 R doses at dose rates of 316 or 26.6 R/min. The rooting of the plants was inhibited considerably more at the higher dose rate than the lower dose rate. Acanthosis and epilation of the skin in the guinea pigs also were greater at the higher irradiation dose rate. These differences were similar when the focus-skin distance was altered. In human patients erythema was greater after 375- to 400-R doses of x irradiation when the dose rates were increased. (BBB)

2761 STUDIES ON PREOPERATIVE IRRADIATION OF LUNG CANCER. Kono, Hiroshi (Chiba Univ., Japan). Nippon Kyobu Geka Gakkai Zasshi, 17: 895-915 (Aug. 1969). (In Japanese).

Of 211 cases of primary lung cancer, preoperative irradiation of 66 was investigated. These were divided into two groups: Group A, in which the primary cancer was irradiated, and Group B, in which hilar and mediastinal lesions were irradiated. Clinical findings, histological changes, and experimental studies are discussed. Results indicated that the optimum dose was 4000 R and the optimum time before surgery was ten days. The effects of preoperative irradiation on clinical symptoms were more pronounced in Group A than in Group B. Hematopoietic function was disturbed more in Group A than in Group B. Bronchial fistula developed more frequently in the irradiated group than in the non-irradiated group. The survival rate of group A was longer (5 years) than that of group B and the non-irradiated group. It was concluded that preoperative irradiation should be applied to hilar and mediastinal lesions rather that to the primary tumor. In an experiment in which carbon was injected into a rabbit's lung, the lymph route from the lung hilum to the upper mediastinum was obstructed. Another experiment with Brown-Pearce tumor cells revealed that metastases developed later in hilar and mediastinal regions of the irradiated group than in the non-irradiated group. (NSA of Japan)

2762 CERVICAL ESOPHAGEAL RECONSTRUCTION FOR HEAVILY IRRADIATED PATIENTS: FEASIBILITY OF A ONE-STAGE PROCEDURE. Fredrickson, John M. (Univ. of Toronto); Strahan, Ronald W. Arch. Otolaryngol., 90: 164-70 (Aug. 1969).

Five cases (four of whom were heavily irradiated), requiring laryngopharyngectomy and cervical esophageal reconstruction, are presented and pertinent details reviewed. Despite poor wound healing all patients eventually achieved total rehabilitated gullet function. Patients treated with high dosage radiotherapy followed by radical surgery have a higher incidence of wound complications due to the occlusive arterial pathology that develops in irradiated tissue. All of the irradiated patients developed fistulas. Tissue necrosis with subsequent fistula formation, infection, and threatened carotid blowout are frequent following extensive surgery for advanced hypopharyngeal cancer in heavily irradiated patients. Changes seen in irradiated vessels, some of which were shown experimentally to occur as early as 16 to 18 days following irradiation, are illustrated. The most striking morphologic alteration, and the one that correlates with the functional abnormality, is the enormous endothelial cell proliferation producing arterial occlusion. To avoid carotid exposure the artery is protected with the levator scapula muscle in irradiated patients. The lower one quarter of the sternocleidomastoid muscle is used to anchor the levator scapula inferiorly providing complete carotid coverage. (BBB)

Radiation Effects on Animals

Refer also to abstracts 2565, 2618, 2627, and 2636.

2763 (COO-78-208) KINETICS OF CELL VOLUMES OF MAMMALIAN CELLS CULTURED IN VITRO. Rosenberg, Howard Martin (Case Western Reserve Univ., Cleveland, Ohio). Sept. 1969. Contract W-31-109-eng-78. 73p. Dep. CFSTI. Thesis.

A simple graphical method for analyzing cell volume spectra was used to study the kinetics of volumes of individual cells during an experimentally-induced absence of cell division. Murine lymphoma (L5178-Y) cells were used most extensively in these studies. Log phase populations of cells were treated with selected agents known to block the progression of a cell through the mitotic cycle. FUdR and hydroxyurea were used to inhibit DNA synthesis, ionizing radiations were used to create a block in G_2, and colchicine was used to block the cells in mitosis. The following inferences were made concerning the volume growth of L5178-Y cells: Cell volume increased exponentially (not linearly) from one division to the next with an average first order rate constant approximately equal to that which describes the increase in cell number in a log phase population. DNA synthesis per se did not contribute significantly to cell growth between divisions. The amount of DNA in the normal (uninhibited) cell, ranging from one to two times that present in cells in G_1, was not the rate limiting factor for volume growth between divisions. Increases in cell volume were probably related to protein synthesis. A cell has the potential for increasing in volume for 3 to 4 hr after RNA synthesis has come to a halt (or after the rate of such synthesis was greatly reduced). If DNA synthesis (and, therefore, division) is prevented, the cell can continue to increase in volume with an unaltered first order rate constant up to a time that approximately corresponds to the scheduled mitosis for that cell; thereafter, it can continue to increase in volume with a first order rate constant that depends on the amount of DNA in excess of that present in cells in G_1. Two other mammalian cell lines were treated with hydroxyurea: mouse strain L cells and Chinese hamster ovarian fibroblasts. A comparison of the results of these studies with the results from studies using similarly treated L5178-Y cells suggested inherent control mechanisms or the timing of such mechanisms within the cell cycle may vary among different cell lines. (auth)

2764 RADIOLOGICAL CONTRIBUTIONS TO THE TREATMENT OF MALIGNANT TUMORS. Hug, O. (Univ., Munich). Z. Laryngol., Rhinol., Otol., 46: 324-37 (May 1967). (In German).

Results of radiobiological studies of irradiation effects were discussed. These included in vitro effects, such as characteristic survival curves of x-irradiated hamster kidney cells, cultured human cells irradiated with ^{210}Po α particles or 250-KV x rays under N_2 atmosphere, inactivation and recovery curves for isolated mammalian cells after irradiation doses of up to 1.4 KR, theoretical inactivation curves for multiple, fractionated x irra-

diation, and theoretical effects of dose rates of from 5 to 500 R/hr on cell survival. Effects of hyperbaric O_2 on irradiation sensitivity of tissues were discussed. Irradiation injuries of normal mouse cells were reviewed briefly. Differences between effects of x irradiation on anoxic and O_2-treated tumor cells were illustrated, and histological effects of irradiation on cell structure were described. The possible cellular bases for the observed effects of irradiation on tumor cells were discussed. Effects of dose multiplication were related to a range of single doses up to 3000 rad, and relations between dose/rad and fractional dose were illustrated. Cumulative dose effectively, tumor recurrence frequency, total irradiation time, and irradiation dose level administered were discussed. (BBB)

2765 CHANGES IN MEMBRANE STRUCTURES OF THE CELLS IN OVOPOIETIC ORGANOIDS UNDER THE INFLUENCE OF IONIZING RADIATION. Bojadzieva-Mihajlova, A. G. Izv. Inst. Morfol., Bulg. Akad. Nauk., 13: 53-61(1968). (In Bulgarian).

Changes in membrane structures of the cells in the ovopoietic organoid of white mice after irradiation in vivo with 600 to 1200 R and with 1200, 10,000, 40,000, and 80,000 R in vitro were studied. Reduction of the ribosome number, formation of round cysts in the cytoplasm, lesions in the membrane structure of the mitochondria, and changes in the nuclear and cytoplasmic membrane were observed. By irradiation in vitro lesions of the nuclear and cytoplasmic membranes, reduction of the ribosomes and mitochondria of the oocyte were noticed, while in the satellite cells there were membrane remnants in the cytoplasm. It was suggested that the problem of membrane changes ought to be considered carefully, having in mind the dynamics of cell processes and also its functional condition and destination. (Abstr. Bulg. Sci. Med. Lit.)

2766 RADIOSENSITIVITY OF LYMPHOCYTES. Ueno, Yori (Kyoto Univ.). Saishin Igaku, 24: 1382-9(July 1969). (In Japanese).

Radiosensitivity of cells, especially of lymphocytes is discussed. Cellular reactions to irradiation include giant cell formation, cell division delay, chromosome aberration, morphological changes, reproductive death, and interphase death. Of various cells, lymphocytes are known to be highly sensitive to radiation. This is indicated by a much faster decrease in the number of lymphocytes in peripheral circulation compared with other kinds of cells. In contrast to this, sensitivity of the lymphocytes with antibody formation capacity is found to be lower. Recent literature on these topics are reviewed. (NSA of Japan)

2767 RELATION BETWEEN RADIOSENSITIVITY AND CELL CYCLE TIME OF ASCITES HEPATOMA. Matsuzawa, Taiju (Nagoya Research Inst., Japan); Nakamura, Mamoru. Nippon Igaku Hoshasen Gakkai Zasshi, 29: 315-18(June 1969). (In Japanese).

The radiosensitivity of the ascites hepatoma cells as a function of their cell cycle is estimated. The ascites hepatomas of 5 lines used in the experiment were AH 130 F(N), AH 13 R, AH 7974 F, and AH 66 F consisting of free tumor cells. Each tumor cell suspension was γ-irradiated by the telecobalt source (Toshiba) in aerobic conditions. Five days after tumor cell transplantation into the peritoneal cavity of rats, the total number of ascites tumor cells was estimated and the dose-survival curves were obtained for the 5 lines of cells. Except for AH 66, D_0 and n of each line of ascites tumor cells were successively calculated from the dose-survival curves. The D_0 of AH 130 F(N), AH 13 R, AH 7974 F, and AH 13 were 320, 270, 210, and 160 rads, and the duration of their cell cycle was 12.6, 16.2, 19.1, and 22.0 hr respectively. These results led to the conclusion that there is a high correlation between the radiosensitivity of the ascites hepatoma cells and their cell cycle; the lower the radiosensitivity, the shorter the cell cycle. (NSA of Japan)

2768 RADIOSENSITIVITY OF AGGREGATED TUMOR CELLS. Matsuzawa, Taiju (Nagoya Research Inst.); Abe, Mitsunobu. Nippon Igaku Hoshasen Gakkai Zasshi, 29: 319-21(June 1969). (In Japanese).

The alteration of the radiosensitivity of cells by aggregation is demonstrated. Ascites Hepatoma 13 cells in Hanks solution aggregated each other after incubation at 37°C during 3 hrs. Control and aggregated tumor cell suspensions were irradiated with the telecobalt source (Toshiba) in aerobic conditions. Five days after tumor cell transplantation into the peritoneal cavity of rats, the total number of ascites tumor cells in an exponentially growing population was estimated and the dose-survival curve was obtained for both aggregated and control tumor cells. D_0 and n were calculated from these dose survival curves respectively. There was no significant difference in n on extrapolation between aggregated and control cells. However D_0 of aggregated tumor cells was 210 R as compared to 160 R for the control. These results led to the conclusion that the radiosensitivity of aggregated ascites tumor cells is lower than that of control free tumor cells. (NSA of Japan)

2769 STUDIES ON THE RADIATION EFFECTS TO THE NERVOUS TISSUE USING TISSUE CULTURE TECHNICS, ESPECIALLY TO THE DEVELOPING NERVOUS ELEMENTS. Nakatani, Yasutaka (Kyoto Prefectural Univ. of Medicine). Kyoto Furitsu Ika Daigaku Zasshi, 78: 527-36(Aug. 1969). (In Japanese).

Cerebellar cultures from mice were exposed to ^{60}Co γ rays with single doses of 250 to 5000 R at different in vitro stages from 2 to 8 DIV. Myelinating rates, obtained from each group, were statistically analyzed. Morphological changes were studied on living tissue and stained specimens with silver impregnation for axons, Sudan black for myelin sheaths, and thionin stain for Nissl bodies. Unirradiated control cultures showed myelinating rates of 54.70 ± 4.47% at 11 days in vitro (DIV) and 94.74 ± 1.96% at 20 DIV. With 500 R irradiated on 3 DIV myelination seemed to be delayed, though the retardation may be recovered by 20 DIV. With 1000 R to 5000 R, retardation and inhibition of myelination took place, depending on the doses administered and the ages of in vitro cultures. The larger the doses administered and the younger the cultures, the greater was the inhibition obtained. Morphological alteration was mainly observed in oligodendroglial cells, represented by acute swelling, pyknosis, and disappearance. It is, therefore, suggested that degeneration of oligodendroglia was responsible for the inhibition of myelin formation. This also produced vulnerability of myelin sheaths once they were formed. (NSA of Japan)

2770 EFFECT OF γ-IRRADIATED AVIAN SEMEN ON REPRODUCTIVE PERFORMANCE. Hyre, H. M.; Patrick, Homer (West Virginia Univ., Morgantown). Poultry Sci., 48: 737-9 (Mar. 1969).

The influence of γ irradiation on avian semen was measured in progeny on the basis of such traits as egg production, egg size, shell quality, interior egg quality, fertility, and hatchability. Two lines of Single Comb White Leghorns were established from the semen from 10 males pooled and separated into two equal parts. One part was given 1500 R of ^{137}Cs γ radiation. The irradiated line was established by artificially inseminating the hens with the irradiated semen and the nonirradiated line with normal semen. Subsequent generations were produced from 15 males and 90 females per line. Each generation in the treated line was produced from irradiated semen to determine any accumulative effect. Results indicated that egg production of progeny produced from sperm that was irradiated with 1500 R was not affected, nor were egg weight, shell quality, interior egg quality, and mortality during the laying period. The coefficient of variations for egg production was greater in the treated line in two of the four generations. Fertility and hatchability were both greatly reduced by sperm irradiation used in this study. (BBB)

Invertebrates

Refer also to abstracts 2582, 2583, 2631–2634, 2713, 2721, and 2857.

2771 RECOVERY AND MODIFICATION OF RADIATION-INDUCED DIVISION DELAY IN DEVELOPING SEA URCHIN EGGS. Failla, Patricia (Argonne National Lab., Ill.). Radiology, 93: 643-8(Sept. 1969).

Recovery from γ-radioinduced division delay in sea urchin eggs (Arbacia punctulata and Lytechinus pictus) was shown to occur when the normal cell division time was extended by temporary treatment with a number of agents, except the lowering of temperature. Possible mechanisms involved in recovery from radioinduced delay of cell division are discussed. (C.H.)

2772 A STUDY OF THE DEVELOPMENT OF A NUCLEAR-POLYHEDROSIS VIRUS OF HELIOTHIS IN GALLERIA MELLONELLA LARVAE EXPOSED TO GAMMA RAYS. Jafri, R. H. (Panjab Univ., Lahore); Khan, Abdul Aziz. J. Invertebr. Pathol., 14: 104(July 1969).

The development of nucleopolyhedrosis virus was found to be inhibited in cells of irradiated Galleria mellonella larvae. The larvae, 10 to 12 mm long, were exposed to ^{60}Co γ rays at doses of 1, 3, 5, 10, and 15 kR at the dose rate of 1 kR/9.3 sec. A suspension of the virus was injected per os into the larvae 3 hr after exposure. Histopathological studies showed that in unirradiated larvae the course of development of a nuclear-polyhedrosis virus of Heliothis in G. mellonella larvae was similar to that of generally known nuclear polyhedroses in lepidopterous larvae. In larvae exposed to 1, 3, and 5 kR and to virus in the post-irradiation period, it was found that up to 72 hr following irradiation some of the nuclei of the cells of hypodermis, fat body, and midgut epithelium were swollen, and some were detached from the nuclear membrane.

From 72 to 96 hr following inoculation, some inclusion bodies or young polyhedra were seen in some nuclei of cells of midgut epithelium, adipose tissues, and hypodermis. On the fifth and sixth days following inoculation most cells of these tissues were filled with polyhedra. From 5 to 8 days following inoculation, some nuclei of these cells had disrupted, liberating the polyhedra. There was considerable breakdown of cells of hypodermal and adipose tissues from day 7 to day 9. Muscle sheath, muscles, and the epithelium of the nerve cord were attacked by the virus on days 9 and 10 following inoculation. In larvae that had received virus after exposure to 10 and 15 kR, polyhedral bodies were fewer in number and appeared only in some cells of the midgut epithelium between 72 and 96 hr, and in the adipose tissues and hypodermis at the end of the first week following inoculation. (BBB)

Vertebrates

Refer also to abstracts 2545, 2570, 2574–2576, 2585, 2586, 2590, 2591, 2715, 2717, 2720, 2722, 2727, 2755, 2760, 2765 2841, and 2843.

2773 (CEA-R-3864) EXTRACORPOREAL IRRADIATION OF CALVES BLOOD. EFFECTS ON: THE LYMPHOCYTES, THE BLOOD-PLATELET FUNCTION, SERIC PROTEINS, AND FIBRINOGEN. Hollard, Daniel; Suscillon, Michel; Benabid, Yvette; Concord, Evelyne; Ivanoff, Michele; Laurent, Monique; Rambaud, Francoise (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug. 1969. 33p. (In French). Dep. CFSTI (U. S. Sales Only).

Animals are divided into three groups as follows: control animals : blood circulation without irradiation; calves that received 40,000 rads during 24 hr of continuous irradiation; and calves that received the same dose, but administered during a period of 5 days (5 hr every day). The more interesting results are: the early lymphopenia that persists for 7 or 8 weeks and may be in relation with the change of immunoglobulins; a constant hyperfibrinemia (12 g/l) never reported, as far as we know, by authors using I.E.C. Several hypothesis are advanced to explain this phenomenon. (auth)

2774 (NYO-4039-1, pp 17-19) RADIATION EFFECTS ON MAMMALIAN EMBRYOS IN VITRO. Casarett, Alison; Kirkpatrick, Jay (New York State Veterinary Coll., Ithaca).

A method was established for the culture of mouse embryos in vitro in which they are removed from the oviducts at the two-cell stage, and maintained in an artificial medium in a CO_2 incubator through the hatched blastocyst stage of development. Preliminary experiments have established the morphologic effect of various estrogen and progesterone levels in the incubation medium. The availability of this type of preparation opens the way to numerous types of controlled studies of radiation effect. (auth)

2775 (NYO-4039-1, pp 134-49) STUDIES ON RADIATION-INDUCED GUSTATORY AVOIDANCE BEHAVIOR. Tapper, D. N. (New York State Veterinary Coll., Ithaca).

During the current contract period, emphasis was given to the use of the radiation-induced gustatory avoidance paradigm to study gustatory physiology and behavior. Most of the effort was directed toward gaining data on how rats group gustatory stimuli by observing how they generalize the conditioned aversion of a specific chemical solution to other solutions of the same or different chemicals. In addition, the microstructure of the fluid licking patterns of these animals was studied. It was found that licking behavior is a readily isolated sensory-motor system that is under fine and rapid gustatory control. Pilot studies were considered on the use of radiation-induced gustatory aversion to assess the effectiveness of radioprotective compounds. (auth)

2776 (NYO-4039-1, pp 150-62) BIOLOGICAL EFFECTS OF IMPLANTED NUCLEAR ENERGY SOURCES FOR ARTIFICIAL HEART DEVICES. Comar, C. L.; Kallfelz, F. A.; Casarett, A.; Craig, P. (New York State Veterinary Coll., Ithaca).

This study was designed to obtain information regarding the potential radiation hazard to man from the use of nuclear energy sources as a means of power for artificial hearts. Mock sources, producing either the same radiation as a useable energy source, or five times this amount of radiation, but having no accompanying heat, were implanted into large dogs (Labrador Retrievers) and clinical, dosimetric, and pathologic data were collected on these animals as a function of time after implantation. (auth)

2777 RADIATION-INDUCED DELAYED UNION OF FRACTURES. Green, Nathan; French, Samuel; Rodriquez, George; Hays, Michael; Fingerhut, Aaron (Los Angeles County Harbor General Hospital, Torrance, Calif. Univ. of California, Los Angeles). Radiology, 93: 635-41 (Sept. 1969).

The pathophysiology of γ radioinduced delayed union of bone fractures was studied using four groups of rats. Group I had unilateral fractures. Group II had bilateral fractures with unilateral irradiation to 2,000 R over two weeks. Group III had bilateral fractures with unilateral irradiation to 2,000 R over two weeks and intraperitoneal cysteamine 125 mg/kg twenty minutes prior to each course of irradiation. Group IV had bilateral fractures with unilateral irradiation over two weeks to 2,000 R with intramuscular depotestosterone, 80 mg/kg per week. By correlating histopathology, barium micropaque angiography, and ^{99m}Tc-albumin and ^{85}Sr scans with count rates, it was concluded that radiation suppresses normal osteoblastic proliferation and neovascularization at the fracture site. Cysteamine selectively protects the effects of irradiation on neovascularization. It does not protect and may enhance the effects of irradiation on osteoblast activity. Delayed union occurs. The interdependence of the vascular pool and osteoblast activity for fracture healing is clearly demonstrated. Cysteamine selective protection of neovascularization may be the mechanism for the enhanced effect of irradiation on osteoblasts. The absence of increased activity with both ^{99m}Tc-albumin scans and ^{85}Sr scans in the irradiated fracture provides an easy, useful diagnostic procedure for the early determination of delayed union secondary to irradiation. (auth)

2778 HYDROCEPHALY FOLLOWING FETAL X IRRADIATION. Senyszyn, John J.; Rugh, Roberts (Columbia Univ., New York). Contract AT(30-1)-2740. Radiology, 93: 625-34 (Sept. 1969).

It is believed that some cases of human hydrocephalus may be caused by radiation injury to the fetus. A study was designed to determine the doses and gestation ages showing statistically significant increments in x-radioinduced hydrocephaly in the mouse. A technic for quantitatively assaying the degree of hydrocephalus is described, and the possible mechanisms for the development of hydrocephalus in mice are discussed. (C.H.)

2779 ERYTHROPOIETIC RESPONSE TO TOTAL-BODY IRRADIATION IN SPLENECTOMIZED MICE. Lisi, Louise; Brady, Luther W.; Brodsky, Isadore; Ruggieri, Susanna T. (Hahnemann Medical Coll., Philadelphia). Radiology, 93: 682-5 (Sept. 1969).

Splenectomized and nonsplenectomized BALB/c female mice received a whole-body dose of 150 rads x radiation, following which erythropoiesis was studied at several postirradiation days up to fourteen days. Parameters studied included hemoglobin, hematocrit, plasma ^{59}Fe in red blood cells, serum iron, plasma iron turnover rates, reticulocyte counts, and liver, spleen, carcass, and femur (bone marrow) localization of ^{59}Fe. The data indicate that the effect of 150 rads whole-body irradiation in both experimental groups is severe, immediate, short-lived depression of erythropoiesis. This depression is followed by rapid erythropoietic recovery. Erythropoiesis in the spleen is shown to be as sensitive to radiation injury as is erythropoiesis in the bone marrow. There are no changes in peripheral hematologic parameters in spite of the marked changes in erythrokinetics. (auth)

2780 EARLY HEMATOLOGICAL DIAGNOSTIC OF IRRADIATION INJURIES COMPLICATED BY BURNS. Vallo, Jozsef; Novak, Janos; Ver, Piroska. Honvedorvos, 21: 48-68 (Jan.-Mar. 1969). (In Hungarian).

Experiments with 32 rabbits exposed to radiation and burns showed the presence of leukocytosis in the early stages of radiation injuries. However, lymphopenia was not observed (which indicated an increase in polymorphonuclear cells and not the reduction of the mononuclear cells). The curves of hematological parameters for combined irradiation and burn injuries, except for strongly expressed leukocytosis, were quite similar to those constructed for the control rabbits exposed only to irradiations. Data obtained confirmed that irradiation was the decisive factor in the animal injuries. (R.V.J.)

2781 VERTEBRAL MALFORMATIONS IN CHICKS CAUSED BY X-RADIATION DURING THEIR EMBRYONIC DEVELOPMENT. Lecyk, M.; Indyk, F. (Univ., Wroclaw). Experientia, 25: 983-4 (Sept. 15, 1969).

Fertilized eggs of White Leghorn hens were incubated at 38°C and exposed to a single dose of 500 R x radiation between the 25th and 72nd hour of incubation. This dose was sufficient to cause malformations of the vertebral column in the embryos. (H.B.G.)

2782 THE ROLE OF THE NERVOUS SYSTEM IN THE MECHANISM OF PRIMARY REACTIONS AFTER IRRADIATION. Kulesza, Romuald; Lipinski, Stanislaw. Acta Physiol. Pol., 20: 441-50 (May-June 1969). (In Polish).

Early postradiation adynamia in rats was studied by determining motility and time of conditioned reflex after electric stimuli, and

the influence of neurohormones on these processes was investigated. Two hundred forty male Wistar rats weighing 180 ± 10 g were subjected to whole-body x-irradiation under the following conditions: 75 R/min, total dose 700 R, intensity 20 mA, voltage 200 kV, filter Cu – 0.5 mm. Experiments were performed one and 24 hr after irradiation. Biologically active substances were injected subcutaneously 5 min before the measurements in the following doses: adrenaline, noradrenaline, and serotonin 0.05 mg, histamine 0.1 mg and acetylcholine 1 mg per rat. (auth)

2783 DEVELOPMENT OF A MYELOPROLIFERATIVE DISORDER IN BEAGLES CONTINUOUSLY EXPOSED TO ^{90}Sr. Dungworth, D. L.; Goldman, M.; Switzer, J. W.; McKelvie, D. H. (Univ. of California, Davis). Blood, 34: 610-32(Nov. 1969).

The toxicity of ^{90}Sr in beagles exposed continuously from midgestation to 1.5 yr of age was studied. A myeloproliferative disorder occurred in dogs fed the two highest dose levels, 12 and 4 μCi ^{90}Sr/day, respectively. Ten cases occurred thus far at the highest level and four at the second highest, the difference in incidence being approximately equal to the threefold difference in dose rate. Age at onset ranged from 14 to 72 months, and cumulative dose rates up to the time of death varied from about 1,000 to 10,000 rads. The 14 cases of myeloproliferative disorder presented a morphologic spectrum that manifested in the acute form as granulocytic leukemia and in the chronic form resembled myelofibrosis with myeloid metaplasia (MMM). Anemia, poikilocytosis, anisocytosis, hypochromasia, and terminal thrombocytopenia were constant features. Terminal leukocyte counts ranged from 3,300 to 38,900 cells/mm^3, with various degrees of shift to the left. Splenomegaly was the salient gross finding in most dogs. Major histologic lesions were pronounced granulocytic proliferation in bone marrow and spleen, with concomitant erythroid and megakaryocytic depletion. Liver, lymph nodes, and a variety of other organs had less extensive and less frequent involvement. In the most acute cases, bone marrow and spleen contained cell populations composed almost entirely of blast cells. (auth)

2784 ELECTRON MICROSCOPY OF THE NORMAL AND ^{131}I-TREATED THYROID GLAND OF THE NEWT NOTOPHTHALMUS VIRIDESCENS. Hearing, Vincent J.; Eppig, John J. Jr. (Catholic Univ. of America, Washington, D. C.). J. Morphol., 128: 369-86(July 1969).

Radioiodine-treated mammalian thyroids demonstrate radiation damage primarily to endoplasmic reticulum, mitochondria, Golgi apparatus, microvilli and cytoplasmic granules, and the nucleus. In addition to some of the previously observed sites of radiation damage, the present study in the newt demonstrated a striking change in nuclear morphology heralding imminent cell destruction as early as 12 hrs after injection of radioiodine. Adult animals, averaging about 3.5 g each, were injected intraperitoneally with 30 μCi of ^{131}I– Na. At 12-hr intervals after injection, thyroid glands were removed for ultrastructural examination. The ultrastructure of the normal thyroid gland is described and compared with that of the irradiated glands. The first visible ultrastructural change observed after injection of the radioiodine was a striking alteration of nuclear morphology. This effect was followed by an increase in the frequency of whorled lamellar structures, a decrease in the number of microvilli, and degeneration of the Golgi apparatus and endoplasmic reticulum. Other effects included an increase in the number of smaller effects, the presence of autophagic vacuoles, and finally, an increase in the number of degenerated mitochondria. (BBB)

2785 CONTRIBUTION TO THE PROBLEM OF THE PENETRATION OF CLOSTRIDIUM OEDEMATIENS FROM THE FOCUS OF MYONECROSIS INTO THE ORGANISM. Erichleb, M.; Konecny, B.; Moravek, F. Cas. Lek. Cesk., 108: 388-92(1969). (In Czech).

In experiments on mice, guinea pigs, and rabbits, cultivation and microscopic evidence was presented for the penetration of Clostridium oedematiens type A 62/54 from the focus of clostridial myonecrosis into the blood circulation and internal organs. The penetration of Clostridium is enhanced by concurrent whole-body irradiation of experimental animals. The importance of prophylactic administration of antitoxic serum aimed to localize Clostridium oedematiens in the focus of infection, reported in literature, was not demonstrated. Penetration of Clostridium oedematiens into the blood circulation of irradiated animals was not inhibited by single administration of tetracycline. (auth)

2786 THE EFFECT OF LOCAL X-RAY IRRADIATION ON LENGTHENING THE PERIOD OF VIABILITY OF HOMOLOGOUS ORGANS AND TISSUE. Lebedeva, E. D. Eksp. Khir. Anesteziol., 12: 43-6(Jan.-Feb. 1967). (In Russian).

Experiments were carried out on 72 white rats that were grafted with a full layer skin flap on the back and on 23 dogs grafted with a homologous kidney into the pelvis with bilateral nephrectomy. Experiments showed that local irradiation of the graft after implantation extended the period of viability of the homologous organs and tissues. However, local irradiation alone created but temporary tolerance to the homograft. (auth)

2787 MORPHOLOGICAL CHANGES IN EXPERIMENTAL ANIMALS SUBJECTED TO SHORT- AND ULTRASHORT-WAVE ERADICATION. Tolgskaya, M. S.; Fukalova, P. P. (Inst. of Industrial Hygiene and Occupational Diseases, Erevan). Gig. Tr. Prof. Zabol., No. 9, 37-40(1968). (In Russian).

In two series of experiments, mice were exposed to short (14.9 mHz) and ultra short (69.7 mHz) electromagnetic (EM) waves. In the first series, 12 animals were subjected to single doses (5000 and 200 v/m for ultrashort waves; and 9000 v/m for short waves). These doses were lethal and caused very pronounced vascular and dystrophic changes throughout the organism. In the second series, 37 animals were given a daily 60-min exposure for 5 months to nonthermal ultrashort wave (150 v/m) and shortwave (2250 v/m) fields. In this series, morphological studies showed slight vascular disorders and compensatory-proliferative processes in the internal organs, changes in the receptor and inter-receptor systems, and slight dystrophic changes in brain cells. The changes evoked by short and ultrashort waves were unidirectional, although short waves produced less pronounced changes. (JPRS)

2788 MORPHOLOGICAL CHANGES IN THE STOMATOGRAPHIC SYSTEM FOLLOWING A LONG-TERM EXPOSURE TO LOW DOSES OF ROENTGEN RAYS. Prokhonchukov, A. A.; Panikarovskii, V. V. Stomatologiya, 48: 38-41(Jan.-Feb. 1969). (In Russian).

Rats were exposed to x rays in a dose of 1 R (summary dosage of 152 R) and the resorption of the osteal tissues in the jaws proceeds almost in the same manner as bone newgrowth. With exposure to x rays with a dose of 5 R (summary dosage of 780 R) the processes of osteal tissue resorption become more intensive, whereas irradiation in a dose of 10 R (summary dosage of 1040 R) makes these processes to prevail markedly over those of the osseous newgrowth. The nature of radiation-induced alterations of the buccal mucosa varies as a function of the x ray doses, starting with manifestations pointing to the atrophy of the mucosa with a mild inflammatory reaction in its subepithelial ground layer in exposures to low doses and ending with ulcerations and necrosis of the mucosa under the effect of high x-ray doses. With the rise of the x-ray dose, dystrophic manifestations (vacuolization and odontoblast pyknosis and patchy atrophy in the dental pulp degenerate into necrobiotic ones, up to and including partial and total necrosis of the pulp attended by the development of inflammatory manifestations in the jaw bone tissue surrounding the tops of the dental roots. (auth)

2789 DEVELOPMENT OF PALATE IN NORMAL MURINE EMBRYO AND INFLUENCE OF VARIOUS AGENTS OF THE CONDITIONS OF PALATINE PLATES AT DIFFERENT STAGES OF EMBRYONIC DEVELOPMENT. Lotosh, E. A. (Inst. of Experimental Medicine, Leningrad). Acta Chir. Plast., 10: 1-6 (1968).

Embryos of mice strain C3HA were fixed in Bouinr's solution between the 13th and 17th day of development and the union of palatine plates was chosen as criterium. In normal animals this union was completed at the end of the 15th day. 200 R x rays, given to the mother at various stages of pregnancy, effected the palatine plate union most severely when administered on the 11th day. Thus, the most radiosensitive period precedes the morphological differentiation in the embryo. In addition to x radiation, the effects of hypervitaminosis A as well as that of cortisone were studied. (H.B.G.)

2790 AN EXPERIMENTAL STUDY ON DEVELOPMENT OF RADIATION INDUCED MALFORMATION IN MICE. Tamaki, Naonori (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 261-83(June 1969). (In Japanese).

The mechanism of radioinduced malformations, with special reference to the relation between fetal malformation and radiation damage to the placenta was studied. The change was examined macroscopically and microscopically using ddO strain mice. The study was performed as follows: The depth dose at the uterus was measured with a small ionization chamber (PTW Simplex Universal Dosimeter), and the absorbed dose (rads) was calculated. Of the bicornuate uterus of the mouse, the embryos of one side were used for inducing malformations, and the other side was used as the control; the same environment and the same pregnant stage were considered to be essential for this study. In order to irradiate one side of the horns, a 1.5 cm thick lead plate having a window covering it, was used to shield the other part of the body. The scattered dose to the uterus on the control side was about 2% of that to the

irradiated one. No histological changes were found on the control side. To find the critical period for development of cleft palate, embryos of the 7½th to 13½th day of gestation were irradiated with 190 kVp x rays, and received two different doses of 193 and 242 rads. The cleft palate developed on embryos of the 7½th to 12½th day of gestation and most frequently on those of the 11½th day. The embryos of the 11½th day of gestation received a dose ranging from 48 to 339 rads, and all that received more than 242 rads developed cleft palates. The fetuses and placentas irradiated with a dose of 242 rads on the 11½th day of gestation were weighed daily and observed histologically. There was retarded growth of the placenta as well as the fetuses. In the histological observation, however, no change could be seen in the placental tissue though the fetal tissue showed remarkable destruction. The fetal weight betan to decrease immediately after irradiation, but the placental weight began to decrease 24 hr later. The rate of retardation thereafter was approximately equal in both. From these findings the retardation of placental growth was considered as a secondary change due to fetal destruction. Histological examination was made to evaluate the radiosensitivity of the fetal and placental tissues according to the germ-forming stage. Early embryos were given doses of 193 and 242 rads at different stages ranging from the 6½th to 10½th day of gestation. In the fetus irradiated at the stage of pre-mesoderm formation, embryonic ectoderm was damaged slightly; on the other hand those irradiated at any stage of post mesoderm formation revealed remarkable destruction in most embryonic ectodermal and mesodermal cells. In the irradiated placenta however, no changes were found in any germ layer at any stage of differentiation. These findings could prove that the placenta has much less sensitivity to radiation than the fetus, irrespective of the stage of the embryo. From this experimental study, it could be concluded that radioinduced malformations are principally due to the direct effect to the fetus and not to the placenta. (NSA of Japan)

2791 INTESTINAL DAMAGE FOLLOWING A SINGLE AND FRACTIONATED IRRADIATION WITH FAST NEUTRONS. Nakagawa, Keisuke (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 241-50(June 1969). (In Japanese).

It was shown that injury of normal and tumor tissues was more intense in fast neutron therapy than with x rays and the injuries were more marked in anoxic conditions. When fast neutron beams are used in radiotherapy, it is important to know the normal tissue damage near the tumors following irradiation. Since small intestine was also irradiated in the treatment of abdominal tumors, the damage of gastrointestinal tract exposed to x rays and fast neutrons in single and fractionated doses was investigated using CRF-1 mice. The energy of x rays was 200 kVp (HVL 1.15 mmCu) and that of fast neutrons was $\overline{En}$ = 2.0 MeV. Iodine-131-labeled polyvinylpyrrolydone (^{131}I-PVP) was used as an indicator of protein loss from the gastrointestinal tract. The results were as follows. On the 4th and 5th days after irradiation, the leakage of ^{131}I-PVP into the gastrointestinal tract was most evident and occurred above the dose level of 500 rads of x rays and 250 rads of fast neutrons. When doses higher than 300 rads of x rays or 100 rads of fast neutrons were used, fecal excretion of ^{131}I-PVP through the intestine increased as the irradiation dose increased. No significant difference of ^{131}I-PVP excretion through the intestine was observed using single and fractionated doses of fast neutrons. From these experiments, the RBE of fast neutrons to x rays for intestinal damage was given as 2.4 for a single dose and 3.2 for 2-fractionated doses. (48 hr interval). (NSA of Japan)

2792 KINETICS OF TRANSPLANTED LYMPHOCYTES IN ANIMALS RECEIVING WHOLE-BODY IRRADIATION. Seki, Masatoshi (National Inst. of Radiological Sciences, Chiba, Japan). Saishin Igaku, 24: 1418-25(July 1969). (In Japanese).

The proliferative pattern of transplanted cells, specifically the difference between lymph node cells and thymocytes was investigated in rats exposed to 1000 R whole-body irradiation. The results of the serial measurements of spleen weight and the splenic concentration of ^{3}H-thymidine were indicative of the difference between the two cells. It was suggested that lymphoblasts were not always dependent upon thymocytes but that thymocytes were highly capable of producing lymphoblasts. Species specificity of the thymus gland was also investigated in the autologous transplantation of thymocytes into rabbits exposed to 1000 R whole-body irradiation. Certain thymocytes were possibly differentiated to bone marrow. Administration of microsome to mice transplanted with lymphatic cells indicated that the function of thymocytes was closely associated with hematopoiesis of bone marrow. (NSA of Japan)

2793 APPEARANCE OF CHROMOSOMAL REARRANGEMENTS IN THE EPITHELIUM OF THE CORNEA OF MICE DURING GENERAL PROLONGED GAMMA IRRADIATION. Zukhbaya, T. M.; Markelov, B. A.; Popova, N. A. Space Biol. Med. (USSR) (Engl. Transl.), 3: No. 2, 111-13(1969).

Translated from Kosm. Biol. Med., 3: No. 2, 71-2(1969).

The effects of prolonged exposure to various doses of whole-body γ radiation on the induction of chromosome aberrations in the corneal epithelium were studied in mice. A total dose of 75 R during a period of 20 hr induced chromosome aberrations. The number of aberrations increased with the radiation dose and time of exposure. (C.H.)

2794 EFFECT OF RUBY LASER ON WHITE GUINEA-PIG SKIN IN TISSUE CULTURE. Lawrence, J. C. (Medical Research Council, Birmingham, Eng.). Non-Ioniz. Radiat., 1: 18-22(June 1969).

A knowledge of the biological effects of laser energy on tissues is clearly relevant to the use of lasers in medicine and in devising appropriate safety precautions. Skin is a suitable choice of tissue for experiment as it is the part of the body most immediately exposed. Experiments were made to see what effect coherent light at 694 nm had on thin slices of white guinea pig skin cultured in vitro. Histology showed that high laser doses were required to cause immediate damage to skin, but lower doses retarded epithelial migration in skin cultured for three days after exposure. Respiration measurements showed that skin exhibited a graded response to laser radiation and that the degree of damage sustained could be correlated with the microscopical appearance of three-day cultures. The results obtained were consistent with the hypothesis that skin damage caused by laser radiation is due to the absorbed energy converted to heat within the specimen. (auth) (UK)

2795 PARTICIPATION OF HOST IN LEUKEMIA INDUCED BY VIRUS AND RADIATION. Yokoro, Kenjiro; Takaaki, Ito (Hiroshima Univ.). Nippon Byori Gakkai Kaishi, 56: Suppl., 297-304(1967). (In Japanese).

An investigation into the possibility of transformation of the type of leukemia because of modification of host factors was conducted in mice. Topics studied were: the possibility of an extended width of the target cell of Gross's virus and Moloney's virus due to the changes in the physiological condition of host cells; the pathogenicity of Rauscher's virus and Friend's virus in nonsusceptible allogeneic hosts and xenogeneic hosts; and differences in the types of induced leukemia due to difference in the mechanism of action of leukemogenic agents (external x radiation and interstitial radiation by ^{90}Sr) on target cells and the involvement of leukemogenic viruses in the mechanism of induction. The possibility was emphasized that in the emergence of viral leukemia target cells are selected according to the physiological condition of each hematopoietic cell system to determine the disease type. A high rate of leukemia induced by radiostrontium, which had been regarded to be poor in leukemogenicity, was attained. The specificity of disease type and the basic changes of the hematopoietic tissue during the preleukemic period were investigated in comparison with those in leukemia induced by radiation, and the indication of viral involvement in the mechanism of emergence. (TSS) (NSA of Japan)

2796 EXPERIMENTAL STUDY OF CICATRIZATION OF THE SMALL INTESTINE IN RATS AFTER ABDOMINAL IRRADIATION. Brunet, M.; Leduco, J.; Guillon, J.-C. (Centre Rene Huguenin, Paris). J. Chir. (Paris), 96: 563-72(Dec. 1968). (In French).

Healing of small intestine was studied in specific-pathogen-free rats irradiated with abdominal doses of 500, 1000, or 1500 R of ^{60}Co γ rays. The female Wistar rats were operated on three days before irradiation to produce intestinal wounds. Mortality was not significantly different in the three groups, and no difference was noted in the histological picture of the healing intestine in relation to radiation dose. The degree of inflammatory cell infiltration was similar in all groups; only the number of mitoses was altered (increased) in the irradiated groups. Examination of various organs showed no significant histologic differences between the three groups or controls. Body weight of the irradiated animals showed a decrease up to the eighth day postirradiation but weight was normal again by the 15th day. Intestinal repair was very rapid in all groups. (BBB)

2797 PROCEEDINGS OF THE FOURTH INTERNATIONAL CONFERENCE ON ORAL BIOLOGY, COPENHAGEN, DENMARK, JULY 15-17, 1968. J. Dent. Res., 48: Suppl., 609-856(Sept.-Oct. 1969). (CONF-680726-(Pt.1, Suppl.)).

Separate abstracts were prepared for two papers presented at the conference. An additional 36 papers were presented on various aspects of oral biology. (H.L.W.)

For abstracts of individual papers see: 2577 and 2798.

2798 RADIATION EFFECTS ON ORAL EPITHELIUM IN MICE. Goepp, Robert A.; Fitch, Frank W. (Univ. of Chicago). J. Dent. Res., 48: Suppl., 641-5(Sept.-Oct. 1969).

From 4th International Conference on Oral Biology, Copenhagen, Denmark. See CONF-680726-(Pt.1, Suppl.).

The effects of radiation on the replacement of mature squamous cells was studied in the dorsal epithelium of the mouse tongue. The findings suggested that the movement of basal cells into the mature population may be due to increased focal pressures in the basal cell layer resulting from the occurrence of mitotic activity in clusters. (auth)

2799 STUDY OF VERTEBRAL CHONDROGENESIS IN THE MOUSE EMBRYO: TERATOGENIC EFFECT OF X IRRADIATION. I. TOPOGENESIS OF MALFORMATIONS OBSERVED AT FULL DEVELOPMENT. Novel, Madeleine (Institut National des Sciences Appliquees de Lyon, Villeurbanne, France). Ann. Biol. Anim., Biochim., Biophys., 9: 41-54(1969). (In French).

In the mouse, day 10 of embryonic life is a critical period for vertebral organogenesis. A total-body, 300 R dose of x radiation administered at this stage induced only an 18% increase in embryonic mortality, but caused vertebral malformations in 92% of surviving embryos including nonossification (day 18), fusion between consecutive centers, and bilateral ossification. With the exception of fusion, the distribution pattern of these abnormalities was similar to that of organogenetic differentiation. Bilateral ossification occurred in early ossified centers whereas reduction and absence occurred in late ossified centers. This points out the importance of morphogenetic changes and differentiation in the genesis of abnormalities, and the part played by axial dissynchronism in their diversification. Four types of abnormalities were noticed in the rib, i.e., angulation, deficiency, fusion, and change in number. The occurrence of angulation, deficiency, and fusion seemed not to be related to topography, whereas change in number of elements mainly affected the border of the thoracic cage, with peculiarities specific for the Swiss/gif strain. (BBB)

2800 MATHEMATICAL ANALYSIS OF THE SPONTANEOUS ELECTRIC ACTIVITY OF THE CEREBRUM AFTER IRRADIATION. Boychev, St. Voenno Med. Delo, 24: No. 2, 27-32(1969). (In Bulgarian).

Changes in the spontaneous (background) activity of the brain on x irradiation of cats with x rays at a dose of 750 R were determined. EEG measurements were carried out in the somatosensory region GRSA and in the region of the hypothalamus before irradiation and 1, 3, 12, 24, and 48 hr after irradiation. The results in the form of histograms were subjected to mathematical evaluation. Changes in the predominant rhythm of electrical waves as a result of irradiation were established. The symmetry of histograms observed before irradiation was disturbed following irradiation. In the mathematical analysis of data, the effect of day-to-day variations in reactivity was taken into account and the possibility of unavoidable errors that must arise in connection with the evaluation of large portions of the EEG were considered. 30 references. (JPRS)

2801 DEVELOPMENT AND RADIORESPONSE OF THE PRENATAL BOVINE TESTIS. Matschke, G. H.; Erickson, B. H. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-GEN-242. Biol. Reprod., 1: 207-14(June 1969).

Prenatal development of the bovine testis and its germ cells is described, as well as the effects of ionizing radiation on this process. Fifty-six animals were exposed in utero (400 R, air dose to dam) to about 150 rad of ^{60}Co γ rays at 0.5 R/min. Ages at irradiation varied from 20 to 280 days postcoitum. Histological analyses of testes aged 10 months revealed little or no damage in those irradiated prior to day 70 of gestation, but at about this age 69% of the 1200 tubule cross sections examined were sterile. The percentage of sterile cross sections increased slightly in testes irradiated at day 110 and remained unchanged to day 120. Thereafter, the magnitude of the irradiation effect diminished and only 20% of tubule cross sections were sterile in testes irradiated at 270 days of gestation. Irradiation (150 rad) administered to fetuses between 80 and 130 days of gestation reduced numbers of gonocytes per 600-tubule cross sections in testes excised 3 to 19 days postpartum to 9% of control levels. Both the potential for recovery and the presumed permanence of the effect of primitive germ-cell destruction are illustrated by the data. Following irradiation at day 110 prenatal, the 78% sterile-tubule-cross-sections value in testes excised at 6 months postnatal was reduced to 52% in testes 2 yr of age at excision and was reduced further to 18% in testes taken from bulls at 6 yr of age. Semen of bulls irradiated at 90 to 150 days prenatal and tested for sperm-producing ability at 2 yr postnatal contained 73% fewer sperm and 40% more abnormal sperm than controls. (BBB)

2802 THRESHOLD DAMAGE FROM CO_2 LASERS. Peabody, Robert R. (Stanford Univ., Palo Alto, Calif.); Zweng, H. Christian; Rose, Heinrich W.; Peppers, Norman A.; Vassiliadis, Arthur. Arch. Ophthalmol. (Chicago), 82: 105-7(July 1969).

Threshold damage to the eye from the CO_2 laser is limited to the corneal and precorneal layers. Since this laser emits a 10.6-μ wavelength which is 90% absorbed in a layer of water 25 μ thick, transmission does not take place to deeper ocular tissues. When energy levels are raised or exposure times increased, greater damage can take place in deeper corneal tissues. Since the cornea of lab personnel exposed to CO_2 laser radiation is particularly vulnerable, rabbit corneas were investigated to determine corneal threshold damage levels, and from these data, safety thresholds estimated. Energy densities of 1.2, 0.77, and 0.55 J/cm^2 were found to cause minimal damage to the cornea at exposure times of 55, 10, and 3.5 msec. At these levels the damage was confined to the corneal epithelium and was manifested by a flat, white area of edema that disappeared within 24 hr. A theoretical heat-flow model was constructed to predict temperature rise as a function of depth and exposure time. A comparison of the model with experimental data suggested that a threshold lesion may be caused at a temperature rise of 35°C. (BBB)

2803 LASER IRRADIATION OF THE ANTERIOR SEGMENT OF THE EYE. II. MONKEY EYES. Hallman, Vivienne L.; Perkins, E. S.; Watts, G. K.; Wheeler, C. B. (London Univ.). Exp. Eye Res., 8: 1-4(Jan. 1969).

The lesions produced in the iris of cynomolgus monkeys by a pulsed ruby laser are described and compared with those produced in pigmented rabbits. The two lasers used had energy outputs of 0.8 J and 230 mJ. No visible lesions were produced in clear cornea by single or repeated exposures. However, exposure of the pigmented zone to the beam caused a visible reaction, with disappearance of the pigment. Irradiation through the pupil caused no observable lesions in the lens or anterior vitreous but hemorrhage into the vitreous resulted from severe retinal lesions. Irradiation of the trabecular region over the canal of Schlemm produced a breach in the trabeculae through which blood was seen to emerge into the anterior chamber. The immediate effects of laser irradiation of the monkey iris were more dramatic than in pigmented rabbit eyes. Usually a small explosion appeared to take place, with debris and bubbles thrown into the aqueous. The iris became darker in color at the site of the lesion and the dark area expanded. Lesions produced immediately before enucleation and examined histologically showed swelling of the iris with marked disruption of its surface, necrosis, and vacuolation of the stroma extending posteriorly to half the iris thickness. Blood vessels in this region and in the surrounding unexposed iris were dilated and contained an excess of white blood cells. The chromatophores of the anterior layers of the stroma showed the most marked changes. Differences in the reaction of the iris tissue in the two species were explained by differences in anatomical structure. Pigment liberated from the iris was seen to leave the anterior chamber by infiltration between the muscle layers of the ciliary body. (BBB)

2804 GAMMA RADIOINDUCED CHANGES IN WEIGHT AND FERTILITY OF HEN'S EGGS. Paulov, Stefan; Marek, Vladimir (Univ. Komenskeho, Bratislava). Biologia (Bratislava), 23: 884-9(1968). (In Czech).

Changes in the weight of white leghorn chickens irradiated on the fifth day after hatching were studied. Cobalt-60 irradiation at doses of 200 R, 400 R, and 800 R was administered. Using linear regression equations and straight line regressions, it was discovered that as the radiation dose increased, the weight gain increments decreased proportionally and the difference in weight between the groups of animals constantly increased. Observation for fertile eggs during the six month period revealed a decrease in production of eggs by irradiated hens. However, the relation of the weight of hens to the weight of eggs was equal both in irradiated and control groups. (tr-auth)

2805 REDUCED PLATELET ADHESIVENESS AFTER WHOLE-BODY X-IRRADIATION. Kagnoff, Martin F. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Int. J. Radiat. Biol., 15: 587-90(1969).

A technique is described by which platelet adhesiveness was measured in four adult beagle dogs. Platelet adhesiveness, platelet count, leukocyte count and hematocrit were determined on five days preceding irradiation and daily for 37 days after irradiation. A dose of 150 rads of x radiation was delivered at a rate of 18.2 rads/min. Changes in platelet adhesiveness, platelet count, leukocyte count, and hematocrit are shown by means of a graph. A decrease in platelet adhesiveness was noted 7 days after irradiation and reached a minimum on day 11. Recovery was indicated by day 14 and return to pre-irradiation levels was complete by day 35. Recovery of platelet adhesiveness preceded an increase in the number of circulating platelets. (H.L.W.)

2806 INFLUENCE OF A SINGLE LOCAL IRRADIATION ON REGENERATING STRIATED MUSCLE. Reznik, M. (Univ., Liege). Arch. Biol. (Liege), 78: 91-106(1967). (In French).

In experiments with mice, the skin of the foot was removed and the solar muscle exposed. After periods of 4 hr, 1, 2, 3, and 4 days a local radiation dose of 1500 R was applied. Histological examinations of the muscle were made from 24 hr to 10 days following irradiation. In experiments with rabbits the anterior tibial muscle of each foot was made ischemic by ligation of blood vessels from 5 hr to 5 days later local irradiation was applied to one foot. Histological examinations were made from 24 hr to 10 days after irradiation. Photographs of muscle sections and discussions of the histological changes are presented. It was concluded that local irradiation inhibited regeneration of muscle when applied during the first two days following the muscular lesion. Radiation applied on the fourth day did not modify the course of the regenerative process. (H.L.W.)

2807 EFFECT OF HESPERIDIN-METHYL-CHALCONE ON CAPILLARY RESISTANCE IN THE INTERNAL ORGANS OF THE GUINEA PIG AND THE RAT. Gabor, M.; Antal, A.; Dirner, Z. (Univ. Medical School, Szeged, Hungary). Acta Physiol. Acad. Sci. Hung., 34: 221-6(1968).

Hesperidin-methylchalcone (HMC) considerably increased the capillary resistance (CR) of the small intestine, large intestine, and kidney in guinea pigs kept on a scorbutigenic diet. In x-irradiated rats the decrease of CR shortly after the irradiation could be counteracted by treatment with HMC. Changes in CR of the internal organs of rats subjected to whole-body irradiation were periodic in character. The CR decreased after 1 to 3 hr and markedly increased on the 2nd to 3rd and on the 6th to 7th days after irradiation. (BBB)

2808 EFFECT OF RADIATION ON THE GROWTH OF VERTEBRAE IN THE TAILS OF RATS. III. THE RESPONSE TO CYCLOTRON NEUTRONS. Dixon, B. (Hammersmith Hospital, London). Int. J. Radiat. Biol., 15: 541-8(1969).

Vertebrae in the tails of young rats were irradiated with single doses of cyclotron neutrons under reduced (anoxic), normal, and increased conditions of oxygenation. Oxygen is dose-modifying with neutrons. The oxygen-enhancement ratio is 1.44 (±0.04) for single doses given in air. The RBE of neutrons decreases with increasing dose, and it is suggested that the neutron survival curve for epiphyseal cells in situ is exponential. This is consistent with the failure to obtain a significant sparing effect by fractionation of neutron doses given to rats breathing air. (auth)

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Refer also to abstracts 2624, 2635, 2653, 2659, 2686, 2752, 2754, 2755, and 2760.

2809 RADIATION THERAPY OF CARCINOMA OF THE CERVICAL STUMP. Wimbush, Penington R.; Fletcher, Gilbert H. (Univ. of Texas, Houston). Radiology, 93: 655-8 (Sept. 1969).

The survival rates of patients with carcinoma of the cervical stump are identical to those of patients with cancer of the intact uterus. The results are obtained by highly individualized treatments using, as a rule, high-dose, whole-pelvis irradiation, intracavitary radium, and transvaginal x-ray therapy. (auth)

2810 IZMENENIYA KOZHI POD VOZDEISTVIEM IONIZIRUYUSHCHEI RADIATSII. (Effects of Ionizing Radiation on Tissue). Samtsov, V. I. Leningrad, Izdatel'stvo Meditsina Leningradskoe Otdelenie, 1968. 104p.

Following the action of ionizing radiation on man, changes are observed in the skin that can be classified as initial and secondary. Initial (local) changes of the skin are stipulated as direct damage by ionizing radiation. Among them can be distinguished the acute radiation injuries of skin, manifested by early radiation reactions, radiation alopecia and acute radiation dermatitis, and the chronic radiation injuries of skin, including chronic radiation dermatitis and late radiation dermatosis, indurative swelling, late radiation ulcers, and radioinduced cancer. In patients suffering from radiation sickness, besides the initial changes, there are secondary changes in the skin that are not associated with immediate damage by ionizing radiation, but result mainly from general disturbances that occur as a result of total irradiation. In secondary changes there occurs such disturbances as increased hair, hemorrhagic rash, and certain other manifestations of vascular disturbances (ischemia traces and urticaria), disturbances of the secretory function of the skin (hyperhydrosis and seborrhea), pigment traces and other hyperpigmentations, itching skin, senile distrophy of skin, the increased sensitivity of skin to different external stimuli, and increased susceptibility to infection. Radiation dermatitis and acute and chronic infectious injuries of the skin in radiation sickness are often misinterpreted. 372 references are cited. (tr-auth)

2811 RADIATION-INDUCED MAJOR VASCULAR OCCLUSION IN A PATIENT CURED OF WIDESPREAD METASTASES OF NASOPHARYNGEAL ORIGIN. Gross, Ludwig (St. Vincent's Medical Center, Richmond, Va.); Manfredi, Orlando L.; Frederick, William C. Radiology, 93: 664-6(Sept. 1969).

A fourteen-year cure with x radiation therapy to proved metastatic nasopharyngeal squamous-cell carcinoma in a young adult is reported. An unusual late complication of radiotherapy causing a complete occlusion of the right superficial femoral artery and partial constriction of the deep femoral arteries with involvement of venous return and lymphatics resulted in gangrene and eventual amputation of the right leg after failure of bypass procedures. The significance and mechanism of late radiation effect upon the tumor bed, connective tissue, and host resistance are discussed. The therapeutic benefit and adverse complications of therapy are considered. (auth)

2812 INHALATION HAZARDS IN RADON SPAS. Halik, Jaroslav (VUHEM, Prague). Strahlentherapie, 138: 205-8 (Aug. 1969). (In German).

The radiation dose caused by radon, received by the medical personnel in the thermal stations of West-Boehmen was measured. The results showed that, neither for the radon-baths nor for the other establishments, where a radon-exposure problem exists, was it sufficient to measure the radon activity in the air (up to 519 picocurie/l), but it was necessary to determine the concentration of the alpha radioactive aerosols. It was advantageous to express the risk by the alpha potential energy. The limit values of the measurements for the purpose of radiation hygiene were tabulated. (auth)

2813 CONCERNING LATE RADIATION CANCER OF SKIN. Stiop, L. D. (Inst. of Oncology, Moscow). Med. Radiol., 13: No. 6, 8-12(June 1968). (In Russian).

Observations of the development of x-radioinduced cancer in three patients 57, 35, and 28 yr after radiotherapy are presented. (tr-auth)

2814 BIBLIOGICAL EFFECTS OF IONIZING RADIATION OR PARTICLES AND POSSIBILITIES FOR RECOGNITION OF RADIATION DAMAGE BY MEDICAL EXAMINATIONS. Reif, E. Zentralbl. Arbeitsmed. Arbeitsschutz, 18: No. 2, 35-8(Feb. 1968). (In German).

The basic principles of radiation dosimetry are reviewed and the clinical effects of radiation doses up to 700 rads on patients are discussed. (H.B.G.)

2815 PREVENTION OF DIGESTIVE RADIOLESIONS. Laugier, A.; Schlienger, M.; Le Fur, R.; Eschwege, F. (Institut Gustave-Roussy, Villejuif, France). Sem. Hop. Paris, 44: 449-55(Feb. 8, 1968). (In French).

High doses of radiation (4,000 to 6,000 rads) to the whole or part of the abdominal cavity may disturb the functions of a certain number of vital organs. The seriousness of the lesions is proportional to the dose and extent of irradiation at the level of these vital organs. Irradiation of the whole of the hepatic parenchyma with a dose of 4,000 R in four weeks may cause a fatal hepatitis. At the level of the kidneys a dose of 2,000 R should not be exceeded for hypertension and nephritis may develop. Doses of 4000 R in four weeks at the level of the stomach may cause a gastric ulcer. The maximum dose tolerated by the small intestine is, however, less well known. Rectal lesions may be avoided by correct technique when irradiating the bladder or uterus. Knowledge of these limits of tolerance, careful preparation of the plan of treatment, and careful supervision during treatment, together with various technical measures are the contribution of the radiotherapist in the prevention of these irreversible lesions. Furthermore, surgical displacement of certain vital organs and, in some cases, prior treatment with antimitotic drugs may in some cases be undertaken before radiotherapy. These measures enable one to prevent or reduce the number of lesions of the digestive tract or make them less serious. (auth)

2816 CARDIAC DAMAGE DUE TO RADIOTHERAPY OF PRIMARY LUNG CANCER. Takaoka, Ataru (Kyoto Prefectural Univ. of Medicine). Kyoto Furitsu Ika Daigaku Zasshi, 78: 479-90(Aug. 1969). (In Japanese).

Cardiac damage induced by irradiation was studied to check the theory that the survival of patients with carcinoma of the left lung is poorer than that of patients with cancer of the right lung. The Q-Tc interval on the ECG, i.e., a main sign of myocardial damage was investigated in 34 patients with carcinoma of the lung. When the radiation dose to the heart was more than 4000 R, myocardial damage was observed on the Q-Tc interval with a high frequency of 32 out of 34 cases (94%). The amount of myocardial damage was greater in proportion to the size of the irradiated area and the ra-

diation dose to the heart. Myocardial damage appeared during the latter half of fractionated radiotherapy, reached a peak at termination of the treatment, and returned to normal limits within a month. About 12 months after irradiation organic late effect or secondary myocardosis caused by tumor recurrence or distant metastasis was observed. It is because the irradiated cardiac area is inevitably large that the amount of myocardial damage is high in patients with left lung cancer. These results suggest that the prognosis of patients receiving radiotherapy for intrathoracic or breast cancer might be influenced by radioinduced myocardial damage. (TSS) (NSA of Japan)

2817 CHANGE OF ^{131}I-T_3 RESIN SPONGE UPTAKE AFTER TREATMENT OF HYPERTHYROIDISM WITH ^{131}I. Kinoshita, Fumio; Maekawa, Tamotsu (Tokyo Metropolitan Hospital, Okubo, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 251-60(June 1969). (In Japanese).

A 13 yr followup of the results of radioiodine therapy on about 500 patients is presented. There were some cases in which hypothyroidism developed after treatment and this post treatment hypothyroidism increased year by year (15 to 20% after more than 10 yr) even though 7000 to 8000 rad was used and is believed to be an adequate dose for radioiodine treatment of hyperthyroidism. Diagnosis in the early stage of hypothyroidism caused by radioiodine therapy, is very difficult, but the patient suffers from various complaints and the state of hypercholesteremia and low metabolic rate cause many other diseases, so it is necessary to make an early accurate diagnosis. For the past 5 yr, the measurement of ^{131}I-T_3 RSU was done routinely in all cases of thyroid diseases, and the results of this test reflected to a remarkable degree the clinical course of thyroid disease. The change of ^{131}I-T_3 RSU in hyperthyroid patients treated with radioiodine for a long period of time was studied. The pattern of ^{131}I-T_3 RSU after radioiodine treatment can be divided into two groups. Group A is cured successfully by the first treatment and group B is not cured and needs the second treatment. The patterns of group A are classified into five types and group B are classified into three types. Each pattern furnished valuable information for further treatment. The result of ^{131}I-T_3 RSU that was followed up for a long period of time, showed a gradual decrease to 25.2%. The cases that showed less than 25% contrarily increased to 43% with or without hypothyroid symptoms. It was thought that most of the cases that showed less than 25% without clinical hypothyroid symptoms would become hypothyroid before long. From these observations, 7000 to 8000 rad seems to be too large a dose and 6000 rad is believed to be the optimum dose that should give fewer late effects. Sometimes antithyroid drugs are used 1 month after radioiodine treatment in anticipation of late radiation effects. (NSA of Japan) (TSS)

2818 STEREOTACTIC TRACTOTOMY THEATRE ROUTINE. Clarkson, Gwen (Brook General Hospital, Woolwich, Eng.). Nursing Times, 65: 587-9(Mar. 8, 1969).

The technique used for implantation of ^{90}Y seeds in the pituitary is described and illustrated with information on the handling of the radioactive source and prevention of undue exposure of operating personnel. As a precaution against excessive radioactivity, the McCaul's implantation apparatus was tested with a Geiger counter at the end of a session. It usually showed a slight degree of radioactivity. It is therefore left in a darkroom for 24 hr until the activity drops, then is sterilized for the next session. For routine operations using radioactive materials, certain alterations to the operating room were made and certain precautions observed. The exit doors were lead lined, and lights inserted to indicate the room was in use. Permanent records of the distribution of the ^{90}Y seeds are also required. This is done by filling in the dosage in the operating room register. All personnel in the theater, medical and nursing, wear film badges, which are returned for assessment regularly. Yttrium-90 rods are stainless steel or nylon coated; therefore, the radioactivity is from a sealed source. The rods are 1 mm long. The rods are safe when in a metal container 2 mm thick. They are supplied with an activity calculated to give a dose of 48,000 to 55,000 rad at time of implantation. The necrotic effect extends up to 3 mm from the seed's surface into the brain. The seeds (or rods) are sterilized by autoclaving at 120°C for 20 min. The seeds are kept locked in a control room when not in use. The technique of implantation is described. (BBB)

2819 ARTERIAL HYPERTENSION IN RENAL TUMORS IN THE INFANT: INFLUENCE OF PREOPERATIVE RADIOTHERAPY. Veraguth, P.; Chanson, J. F. Helv. Chir. Acta, 36: 355 (July 1969). (In French).

It is reported that Wilm's tumor in the infant is frequently accompanied by arterial hypertension that can be lowered or normalized by the effect of preoperative irradiation. Doses of 1500 to 2000 R per field of x rays or high-energy electrons were used. This reduction in hypertension induced by irradiation was demonstrated in three patients. In cases of Wilm's tumor, arterial hypertension appears to have a certain prognostic value, even though the pathogenesis of this condition has not been clarified. The appearance of metastases or the recurrence of the original tumor may cause a renewed rise in arterial blood pressure. (BBB)

2820 INDIRECT OPTHALMOSCOPY: IS THE ILLUMINATION LEVEL DANGEROUS. Pomerantzeff, Oleg; Govignon, Jacques; Schepens, Charles L. (Inst. of Biological and Medical Sciences, Boston). Trans. Amer. Acad. Ophthalmol. Oto-Laryngol., 63: 246-51(Mar.-Apr. 1969).

Formulas are given for levels of retinal irradiance in ophthalmoscopy. A curve of energy distribution is shown for the total flux entering the patient's eye in direct and indirect ophthalmoscopy. It is shown that irradiance is greater with indirect than with direct ophthalmoscopy, although the values are of the same order. The radiations emitted by the ophthalmoscopic light source contain approximately 90% infrared and 10% visible light which is the only portion used for observation. Infrared radiations between 0.8 and 1.4 μ enter the eye and 50% are absorbed by the ocular media. It was found that no damage was done to normal eyes after the infrared light was filtered. It is recommended that illumination be kept at the lowest level that will yield necessary information, reasonably short exposures be used, and that an infrared filter be incorporated in all indirect stereoscopic ophthalmoscopes of the Schepens type. (H.L.W.)

2821 LONG-TERM EFFECTS OF RADIOACTIVE IRON ADMINISTERED DURING HUMAN PREGNANCY. Hagstrom, Ruth M.; Glasser, S. R.; Brill, A. B.; Heyssel, R. M. (Vanderbilt Univ., Nashville). Contract AT(40-1)-2401. Amer. J. Epidemiol., 90: 1-10(July 1969).

The effects of maternal and prenatal exposure to ^{59}Fe were analyzed 18 to 20 yr after exposure. Of 751 pregnant women attending a prenatal clinic who received the orally administered isotope in a study of iron metabolism in pregnancy, 679 (90%) were located and their experience compared with 705 (91%) of 771 women who did not receive radioiron. The estimated radiation dose to the fetus was 5 to 15 rad, and for the mother the estimates were 0.2 R to blood and 0.02 R to total-body tissues. These calculations were based on measurements suggesting a body burden of ^{59}Fe of 2 to 4 μCi. Frequency and type of malignancy occurring in the followup period did not differ for the two pregnant female groups. Effect of prenatal exposure to radioiron was also analyzed in children born to these mothers. For 634 exposed children, one case of leukemia and two cases of sarcoma were discovered. No malignancies occurred in the 655 children in the unexposed group. This represents a small, but statistically significant increase ($p = 0.03$), and is said to be consistent with previous radiobiologic experience. No difference in frequency or type of congenital defect was noted for exposed compared to nonexposed children when analyzed by trimester of radioiron administration. For later children born to the exposed mothers, no differences in frequency or type of congenital defect were noted when compared with subsequent children of nonexposed mothers. (BBB)

2822 HAZARDS OF X-RAY DIAGNOSIS. Broda, Engelbert (Univ., Vienna). Naturwiss. Rundsch., 22: 257-9(June 1969). (In German).

Various reasons for irradiation injuries occurring in x-ray diagnosis were reviewed, including lack of attention to proper radiation safety practices, overdosage, and use of Thorotrast or Peteosthor. The early tumors in U miners and Ra dial painters observed as early as the twenties are discussed. From 1928 on, thousands of patients were injected with Thorotrast (ThO_2). A large number of these developed tumors within 3 to 20 yr after treatment. From 1944 on, many patients received Peteosthor (ThX) as treatment for extrapulmonary tuberculosis and other diseases. In 206 patients who received ThX as children prior to 1951, 35 developed bone sarcomas, and 32 of these have died. Although the causal relation is often difficult to establish, x irradiation can be as injurious as α or β irradiation. To reduce x irradiation injuries incurred in diagnostic studies, physicians must be aware of proper dosage techniques and practices, since even very small doses were shown to produce somatic injuries during growth and differentiation of organs, such as in organs of unborn children. (BBB)

2823 CASE OF BILATERL ANOPHTHALMOS. Pantarotto, M. F.; Sanna, G. (Univ., Genoa). Riv. Ostet. Ginecol, 23: 327-32(Apr. 1968). (In Italian).

A case of clinical bilateral anophthalmia in an otherwise normal subject is described. It is not possible, on the basis of the data, to come to a conclusion regarding the etiopathology of the malfor-

mation observed. It is mentioned that some diagnostic techniques, such as x radiation and drugs, used indiscriminately, may have a harmful effect upon the fetus and particularly on the ocular system. (auth)

2824 OSTEOGENIC SARCOMA SECONDARY TO IRRADIATION AFTER RADICAL MASTECTOMY FOR BREAST CARCINOMA: AN AUTOPSY CASE. Nakamura, Kyoichi; Goto, Hideyuki; Kuno, Keijiro. Shujutsu, 22: 430-6(Apr. 1968). (In Japanese).

2825 RADIORECTITIS AND RECTOSTENOSIS. Inagaki, Hidetomo; Kaya, Kazuo (Gifu Univ., Japan). Nippon Daicho Komonbyo Gakkai Zasshi, 22: No. 2, 44-8(Mar. 1969). (In Japanese).

Radioinduced injuries to the gastrointestinal tract continue to occur in spite of improvements in x-ray equipment and procedures. The impairment of the skin, bones, and urogenital system is unavoidable when radium, x ray, and ^{60}Co are applied to malignant tumors of the pelvic organs. Proctectomy and hysterectomy were performed on two patients who were given radiotherapy for uterine cancer; it was noted that there was a shelf tumor with proliferation of connective tissue around the rectum and the pelvic wall. Nine years following the operation rectostenosis and a pathological condition of the cervix were noted. (NSA of Japan)

2826 RESULTS OF TREATMENT OF THYROTOXICOSIS FOLLOWING RELAPSE AFTER ANTITHYROID DRUG THERAPY. McLarty, D. G.; Alexander, W. D.; Harden, R. McG.; Clark, D. H. (Western Infirmary, Glasgow). Brit. Med. J., 3: 203-5(July 26, 1969).

The incidence of hypothyroidism as a late complication following ^{131}I treatment of thyrotoxicosis was determined in the course of a survey of 130 patients treated with antithyroid drugs. Sixty-eight of the 130 patients were treated with radioiodine initially following relapse. Of these, 33 (48%) subsequently became hypothyroid. Thirty-nine (57%) were cured with 1 dose, 18 (27%) with 2 doses, 2 with 3 doses, and 9 (13%) with more than 3 doses. A further 12 patients received radioiodine following relapse after surgery or antithyroid drugs. The dose in mCi and the incidence of hypothyroidism for all 80 patients are tabulated. Forty-six (57%) remitted after 1 dose and 15 (18%) with 3 or more doses. Forty-eight (60%) received 10 mCi or more and 39 (49%) of the total group became hypothyroid. The period of follow-up ranged from 1 to 12 yr and 11 patients remained euthyroid for over 5 yr after receiving radioiodine. The results of treatment with radioiodine are comparable with the results reported in other series, though the proportion requiring more than 3 doses (1%) is considerably higher. The results of treatment of the patient who relapses after antithyroid drug therapy with radioiodine or surgery are not significantly different from the results of treatment in a newly diagnosed thyrotoxic patient. (BBB)

2827 KINETICS OF THE CHANGES OCCURRING IN THE LEUKOCYTE COUNT IN THE PERIPHERAL BLOOD OF PATIENTS SUFFERING FROM CHRONIC MYELOLEUKOSIS DURING CHEMO- AND RADIATION THERAPY. Dultsin, M. S.; Levitin, E. I.; Osechenskaya, G. V.; Kukharenko, Yu. A.; Kovaleva, L. G.; Evseenko, L. S.; Emanuel, N. M. Probl. Gematol. Pereliv. Krovi, 14: No. 4, 3-9(Apr. 1969). (In Russian).

Changes of the count of leukocytes in 221 patients suffering from chronic myeloleukosis during the course of treatment with constant doses of myelosan myelobromol, dopan, urethane and x irradiation were examined. The leukocyte count in the peripheral blood decreased as a result of myelosan therapy according to exponential laws with statistically reliable differences between the kinetic indices, corresponding to daily myelosan doses of 2 to 10 mg. Kinetic curves of the fall of the leukocyte count with constant doses of myelobromal, urethane, dopan, and x-ray therapy are also well designated by exponential relations; this makes it possible to compare the calculated values of kinetic constants, corresponding to the mentioned therapeutic methods, with kinetic constants, corresponding to various myelosan doses. The data obtained offer a possibility of applying kinetic methods for comparing the efficacy of various types of treatment in chronic myeloleukosis. (auth)

2828 LATE DAMAGE FROM THOROTRAST. XLIII. Heger, N.; Maniatis, N.; Liehr, H.; Beneke, G. (Justus-Liebig-Univ., Giessen, Ger.). Med. Welt., 3: 167-72(Jan. 18, 1969). (In German).

The case history of a 55 yr old man is described. At the age of 33 he was injured by a shell fragment in the neck; this led to an arteriovenous aneurysm that resulted in a brain disorder. A table is presented to show clinical and pathological findings following the use of thorotrast as a contrast medium for radiography. The pathology of lymph nodes, liver, spleen, adrenals, and bone marrow containing thorotrast deposits is discussed and illustrations are presented. Late consequences were chiefly keloid-like callus formations, paravenous and intracavitary deposits, fibrous reconstruction processes of the liver and spleen, and systemic deficiencies of the hemopoietic system. A discussion is given of the properties and composition of thorotrast, fate of thorotrast in the organism, tissue changes resulting from thorotrast accumulations, and the origin of tumors following the use of thorotrast. (H.L.W.)

Radiation Effects on Plants

Refer also to abstracts 2345, 2621, 2629, 2630, 2637, 2639, 2641 2643, 2714, 2716, 2760, 2848, and 2850.

2829 EFFECTS OF OXYGEN IN THE CASE OF POSTRADIATION SOAKING OF SEEDS ON THE YIELD OF CHROMOSOMAL ABERRATIONS. Atayan, R. R. (Armenian Scientific Research Inst. of Agriculture, Echmiadzin, USSR). Radiobiologiya, 8: 709-16(1968). (In Russian).

The postradiation influence of oxygen was investigated on dormant pea seeds during the period of their soaking. The yield of chromosome aberrations in the cells of the roots of the seedlings during the first mitosis was recorded as a test reaction. It was shown that the postradiation action of oxygen leads to an intensification of radiation damage measured at the beginning of the first mitosis. By the end of the mitosis, as a result of the repair processes that occur, the yield of chromosome aberrations is substantially reduced. The data are an indication that oxygen is essential for recovery processes during the first hours of soaking. (JPRS)

2830 THE VARIATION OF THE OAK (QUERCUS ROBUR L.) SEEDLINGS GROWN FROM X-IRRADIATED ACORNS. Kotov, M. M. (Gorky Inst. of Siliviculture and Wood Tech., Yoshkar-Ola, USSR). Genetika, 5: No. 6, 32-9(June 1969). (In Russian).

The effect of irradiation on Quercus robur L. acorns with x rays of different doses was studied. A 1000 R dose stimulated the germinating capacity in the soil, doses of 500 R and 1000 R stimulated the height growth of two-year-old seedlings, 500 R, 1000 R, and 3000 R stimulated the leaf growth, while 5000 R was a sublethal dose. The range of variation of morphological characters of one-year-old seedlings was directly proportional to the radiation dose. Some deviations from the normal state were manifested only during the second year of life. The changed cells were concentrated not only in the root collar, but also in two or three lateral buds. (auth)

2831 CHANGES IN ROOT RADIOSENSITIVITY DURING GERMINATION AND EARLY SEEDLING GROWTH. Burholt, Dennis Robert. Gainesville, Fla., Univ. of Florida, 1968. 83p. Thesis.

Roots of Pisum sativum, Zea mays, and Vicia faba were irradiated with x rays at 1-day intervals for the first 4 days after the onset of germination. The growth rate of the irradiated roots as compared to the growth rate of the controls was used as the criterion of radiosensitivity. An attempt was made to correlate the changes in radiosensitivity with various changes occurring within the meristematic region of the root. From the study of changes occurring in nuclear volume, DNA content, mitotic index, DNA synthesis, and a number of cells present in the root meristem a multifactorial picture of radiosensitivity was obtained. The nuclear volume of cells in the meristematic region of the root was measured by means of stained paraffin sections. In all cases, the time of minimum radiosensitivity was also the time when the average nuclear volume of the meristematic cells was at a minimum. The time of maximum radiosensitivity was also the time when the average nuclear volume was at a maximum. When the energy absorbed per chromosome was calculated for an exposure which reduced the rate of root growth to 50% of the control, it was found to be similar for all time intervals, except for Pisum and Vicia on day 1. The relative DNA content of the cells was measured by the two-wavelength method of Feulgen microspectrophotometry. The variation of DNA content per cell during the first 4 days after the onset of germination was well correlated with radiosensitivity for Pisum and Vicia. However, for Zea the time of minimum radiosensitivity, day 1, was the time when the majority of the cells contained the 4C amount of DNA. Some evidence was obtained that indicated that in Pisum a quiescent center developed between days 2 and 4. The development of the quiescent center could have been a possible reason for the decline in root radiosensitivity observed. (Diss. Abstr.)

Radiation Effects on Microorganisms

Refer also to abstracts 2567, 2571, 2572, 2578, 2589, 2619, 2620, 2622, 2623, 2628, 2638, 2640, and 2858.

2832 (TID-25178) A STUDY OF THE EFFECT OF IONIZING RADIATION ON RESISTANCE, GERMINATION, AND TOXIN SYNTHESIS OF CLOSTRIDIUM BOTULINUM SPORES, TYPES A, B, AND E. Progress Report. Graikoski, J. T.; Kempe, L. L. (Michigan Univ., Ann Arbor. Dept. of Chemical and Metallurgical Engineering). June 1962. Contract AT(11-1)-1095. 29p. Dep. CFSTI.

Human botulism was reported to result from eating fish and seafood products in which Clostridium botulinum Types A, B, and E were allowed to grow. With one exception, all known cases of Type E botulism have resulted from eating fish, fish products, and sea mammals. C. botulinum Type E bacteria have reportedly been recovered from the intestinal contents of fish and from mud samples taken in Japan, British Columbia, Greenland, Denmark, and France. When Type A or B botulism has resulted from eating fish, it is believed to have been caused by incidental contamination during processing, although actual transmission by fish cannot be overlooked. In the present study, six representative strains of C. botulinum Type E were obtained and their sporulation characteristics studied. These bacteria were found to sporulate quite readily in a trypticase medium. This medium also was used to produce large numbers of such spores in 10-liter flasks. The Type E spores were found to be considerably less resistant to γ radiations from ^{60}Co than Type A spores. When suspended in an extract of haddock tissue, Type E spores were more resistant to γ radiations than they were when suspended in phosphate buffer. Growth, sporulation, and toxin synthesis were found to occur quite readily in clam juice and in haddock and shrimp extracts. Toxin synthesis is being studied in radiation-sterilized foods. The aforementioned studies are being extended, and studies of the growth and toxin synthesis in fish and seafood substrates by C. botulinum Type E bacteria in the temperature range of 0° to 30°C are being initiated. (auth)

2833 THE INDUCTION OF THE PROPHAGE OF ESCHERICHIA COLI K 12 (LAMBDA) DURING VARIABLE DURATIONS OF THE STATIONARY PHASE. Noack, D. (Institut fuer Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Z. Allg. Mikrobiol., 7: 383-91(1967). (In German).

Induction of prophage of Escherichia coli K 12 (λ) by uv irradiation was discussed. All wavelengths of uv radiation above 400 nm were filtered out. The dose rate of irradiation was adjusted so that the maximum plaque number was reached after an irradiation time of 2 min. The induction probability, that was the boundary value of induction frequency for extremely large numbers of events, was evaluated as a function of uv dose. Beyond the maximum the irradiation induction frequency went almost exponentially toward zero. During irradiation the ratio of spontaneous frequency to radiation induction frequency approached zero, so that the total induction frequency improved as an estimate of radiation induction frequency as the irradiation time was increased. The slope of the radiation dose induction frequency curve was similar to that of the spontaneous induction frequency curve, but displaced upward along the ordinate. Similar uv irradiation effects were observed for colony frequency. (BBB)

2834 X RADIATION OF SCHISTOSOMA MANSONI: IN VIVO AND IN VITRO EFFECTS. Michaels, Rhoda M.; Kean, B. H. (Cornell Univ., New York). Amer. J. Trop. Med. Hyg., 18: 539-44(July 1969).

The effects on Schistosoma mansoni of sterilization by x radiation were studied in vivo in mice and in vitro. Since the mature egg is the pathogenic unit in schistosomiasis, sterilizing agents, by inhibiting egg laying, should be therapeutic. Advantage was taken of the fact that potassium antimony tartrate (PAT) causes a shift of worms to the liver, which is resistant to radiation. With this method, it was possible to expose worms in vivo to higher doses of x radiation than was previously possible. After the hepatic shift produced by PAT, the livers of the mice were irradiated with 1500 R. The worm and egg burdens, the survival times of the mice, and the morphology of the recovered worms, indicated that irradiation at this dose had no effect. Adult worms were exposed to various x-ray doses in vitro, and subsequently maintained in a medium consisting of 90% Medium No. 199 and 10% calf serum. Death from irradiation began 2 weeks after exposure. The LD_{50} was 68,000 R for males, and 59,000 R for females. As compared with nonirradiated controls, the rate of oviposition was inhibited 50% by 14,400 R and 90% by 100,000 R. The dose used in vivo inhibited egg-laying in vitro by only 4%. Sterilization of adults was measured indirectly by comparing the number of fertilized eggs (those maturing to the miracidial stage) laid after different x-ray doses with those laid by nonirradiated worms. Adults were sterilized 50, 90, and 100%, by 350, 1000, and 5000 R, respectively. The dose used in vivo was 92.5% sterilizing in vitro. The dose of x rays used in vivo could neither sterilize adults nor inhibit egg laying. However, by inhibiting the maturation of eggs, it should have extended the lives of the treated animals. Lack of efficacy in vivo may have been due to irradiation too late in the disease. (BBB)

2835 EXPERIMENTAL MORPHOGENESIS IN CILIATES. II. EFFECTS OF UV RADIATION ON DIFFERENTIATION OF CILIA IN PARAMECIUM AURELIA. de Haller, Gerard (Univ., Geneva). Rev. Suisse Zool., 75: 583-7(Sept. 1968). (In French).

After a strong uv irradiation, surviving clones of Paramecium aurelia showed a structural alteration of their cilia, even after many division cycles. While the kinetosomes look quite normal, the cilia are swollen and miss their typical 9 + 2 fibrillar structure. The peri-basal vesicles are lacking. The nature of these alterations, as well as their genetic origin, are discussed. (auth)

2836 RADIATION RESISTANCE OF AEROBIC BACTERIAL SPORES AND COLONY-FORMING CAPACITY OF SURVIVING SPORES AS AFFECTED BY pH. Farkas, J.; Andrassy, E. Elelmiszertudomany, 2: 59-66(1968). (In Hungarian).

The radiation resistance of Bacillus cereus spores as affected by pH and cell density of the spore suspensions was investigated. The section of the survival curves of suspensions of 10^8, 4×10^3, and 5×10^1 per ml viable cell counts were compared to the extent of three orders of magnitude decrease in viable cell count. It was established that the initial cell density did not affect the radiation resistance of spores. The radiation resistance as affected by pH in the range of 3 to 8 was investigated. The radiation resistance of B. cereus spores was not affected in the range of 5 to 8 pH. By lowering pH below 5, the radiation resistance decreased as compared to that observed in the neutral region. The colony-forming capacity of B. cereus, B. coagulans, and B. pumilus as a function of pH in the nutrient medium and the pH sensitivity of bacterial spores as affected by radiation were also investigated. It was established that irradiation increased the pH sensitivity of surviving bacterial spores in all three strains. The initial phase of spore germination (the phase accompanied by decrease of refractivity of the spores) and the division of vegetative cells proved to be most sensitive to the changes of hydrogen ion concentration. (Hung. Tech. Abstr.)

2837 ESCHERICHIA COLI RIBOSOMES. DISSOCIATION OF E. COLI 70S RIBOSOME BY UV-IRRADIATION. Hara, Akiko; Miyazawa, Fumio; Iwahara, Shigeo (National Inst. of Hygienic Sciences, Tokyo). Igaku To Seibutsugaku, 76: 242-5(May 10, 1968). (In Japanese).

It has been reported that when 70S or 100S ribosomes from Escherichia coli are placed in buffered solution of low Mg^{++} concentration, there is dissociation into the 30S and 50S subunits. This reaction is reversible. A study was made to see whether similar effects could be obtained by uv irradiation. Spectrophotometric analyses of starting ribosome suspension indicated about 80% 70S. When this material was uv irradiated, there was dissociation to 30S and 50S, but the 1:2 ratio of the former to latter associated with Mg^{++} induced dissociation was not evident and there was relatively greater production of 50S. Long term irradiation (13 hours) resulted in an absorption pattern quite unlike anything seen previously. (TTT)

2838 CONJUGATION IN ESCHERICHIA COLI K-12 AND ITS MODIFICATION BY IRRADIATION. Wood, Thomas H.; Walmsley, Roger H. (Univ. of Pennsylvania, Philadelphia). Biophys. J., 9: 391-420(Mar. 1969).

The effect of x radiation on the series of steps in E. coli K-12 conjugation was investigated and compared with previous results obtained with α-particle, ^{32}P decay, and uv irradiation. These steps (union, transfer, integration, and segregation) are described in analytical terms. Only two parameters are utilized: ν^0_{mt}, the probability of interruption of transfer of the male chromosome per unit chromosomal distance; and ν^0_r, the probability per unit chromosomal distance of a recombinational event. Experimentally these two parameters have the same value (0.06 min^{-1} or 10^{-4} per nucleotide pair). Irradiation of the donor parent prior to mating increases the transfer parameter ($\nu_{mt} = \nu^0_{mt} + \sigma_{mt}D$) and a complete description of the radiation response of recombinant production is obtained by a consideration of the single parameter σ_{mt}. Irradiation of the recipient parent prior to mating increases the recombination parameter ($\nu_r = \nu^0_r + \sigma_r D$) and a complete description of the radiation response of recombinant production is obtained by the addition of the parameter σ_r. Experimentally σ_{mt} and σ_r were found to have the same value, about 0.004 $Krad^{-1}$ min^{-1} for x irradiation. For α-particle irradiation the values of these two parameters were 0.006 and 0.008, respectively, and for ^{32}P decay 0.005 and 0.007. It is thus possible to describe mathematically the behavior of the unperturbed mating system by a single parameter ν^0; a single additional parameter σ is adequate to describe the behavior of the system when either parental type is irradiated prior to mating. That ν_{mt} and ν_r have

the same or similar value suggests that common molecular mechanisms are involved in the transfer and integration steps. (BBB)

2839 OVICIDAL EFFECT OF GAMMA RADIATION ON SOME IMPORTANT LEPIDOPTEROUS PESTS OF FOOD GRAINS AND THEIR PRODUCTS. Huque, Heshamul; Khan, Mohammad Allahdad. Food Irradiat., 9: No. 4, 19-22(Apr.-June 1969).

The ovicidal effect of γ radiation against Sitotroga cerealella Oliv., Corcyra cephalonica Stn., and Cadra cautella W. was investigated and it was found that although the three species are very susceptible to γ radiation the susceptibility varies from species to species. Variation in susceptibility appeared to be related to dissimilarity in incubation period of the species, while the ovicidal effect was found linearly proportional to the dose applied and the extent of embryonic development at the time of radiation. Eggs containing a well advanced embryo were comparatively less susceptible and required relatively higher doses for accentuating the susceptibility. Doses applied to the three species were in the order of 0.5 to 25 kR. Ovicidal dose for all the species was 25 kR. (auth)

2840 EFFECT OF RIFOMYCIN ON THE RADIOSENSITIVITY OF SEVERAL STRAINS OF ESCHERICHIA COLI. Pollard, E. C.; Weller, P. K. (Pennsylvania State Univ., University Park). Nature (London), 222: 1173-4(June 21, 1969).

Rifomycin has been shown to bind to the DNA-directed RNA polymerase of Escherichia coli and also to stop transcription. Since this substance readily enters E. coli it was of interest to determine whether it has a potentiating effect on the action of ionizing radiation. A study is described of the effect of irradiation plus rifomycin on DNA degradation in several strains of E. coli, on the formation of colonies, and on the oxygen effect. It was found that when cells are first exposed to rifomycin there is a marked increase in DNA degradation in all strains, and in some strains there is an increase in the sensitivity of colony forming. DNA degradation was observed by using cells auxotrophic for thymine. The cells were grown in ^{14}C-thymine medium. The irradiation procedure involved oxygenation for 1 min and exposure to ^{60}Co γ irradiation at 13,000 R/min, rifomycin being added 10 min previously to a final concentration of 50 μg/ml. The loss of radioactivity in a trichloracetic acid insoluble fraction measured the amount of degraded DNA. Results using 6.7 kR indicated no significant difference between the rifomycin treated control and the untreated, even after stressing the cells with heat. Rifomycin does not release more enzyme to attack the DNA, but releases more DNA to be degraded by the already activated degradation enzymes. The dose dependence of the effect of rifomycin is shown for three insensitive cells. Plating experiments were also performed on four strains of bacteria, fully oxygenated while irradiated, with and without rifomycin. Where degradation was low, or required a considerable dose, the sensitizing effect of rifomycin was marked; where degradation was high and took place at low doses, sensitization was only marginal. The action of rifomycin on cultures irradiated after oxygen or nitrogen bubbling was also compared, and it was concluded that the oxygen effect was unchanged by rifomycin. Mechanisms are discussed. (UK)

2841 PRELIMINARY EXPERIMENTS ON THE USE OF IRRADIATION TO DESTROY ENTEROPATHOGENIC BACTERIA ON FRESHWATER FISH. Mossel, D. A. A.; van Spreekens, K. J. A. pp 449-50 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

Preliminary experiments to test the practicability of irradiation for the destruction of enteropathogenic bacteria on freshwater fish are described. The organisms tested were Salmonella typhimurium isolated from pork, and strains of Klebsiella and Flavobacter isolated from freshwater fish. Inoculations were made into previously irradiated and ground freshwater fish at levels of 10^{10}/g. Radiation doses of 0.1 to 0.6 MRad were used. The survival curves were virtually linear and from these the following Decimal Reduction Values (D) were calculated: Salmonella typhimurium 0.050 MRad, Klebsiella species 0.035 MRad, and Flavobacter species 0.060 MRad. (auth)

2842 UV SENSITIVITY OF GERMINATING CULTURE OF BACILLUS CEREUS. Drobnik, J.; Krekulova, A. (Charles Univ., Prague). Folia Microbiol. (Prague), 14: 104-11(Mar. 1969).

Germinating cultures of Bacillus cereus were chosen as a model system for determining whether there is any correlation between radiosensitivity and replication cycle of nucleic acids. Spores of B. cereus can be germinated with reasonable synchrony, and similar synchrony might be expected in other processes, particularly in mRNA and DNA synthesis. Furthermore, the germinating spore may be considered as a 1-chromosome system, which is not usually the case in vegetative bacterial cells. Survival of germinating cells after uv irradiation is markedly affected by repair. When plated on mineral agar, a linear decrease of survival of cells was obtained between 20 and 60 min of germination, whereas the survival cells on nutrient agar showed only minor fluctuations. The difference in survival of these two media, which reached one to two orders of magnitude, is due mostly to the shape of the shoulder on the survival curve. Survival on mineral agar may be increased by postincubation in complex media or by preincubation in mineral media. It was concluded that repression and derepression of biosynthetic pathways was responsible for the different efficiency of repair. (BBB)

2843 EARLY STEP IN SENDAI VIRUS-MEDIATED RESCUE OF ROUS SARCOMA VIRUS FROM VIROGENIC MAMMALIAN CELLS. Svoboda, J.; Machala, O. (Inst. of Experimental Biology and Genetics, Prague). J. Virol., 2: 951-2(Sept. 1968).

Certain lines of Rous sarcoma virus (RSV)-transformed mammalian cells were found to give rise to detectable virus production only if they are associated with chicken cells. Addition of Sendai virus to the cell mixture was found to enhance RSV rescue. The conditions under which uv-inactivated Sendai virus increased RSV rescue in a mixture of uv-irradiated virogenic RSV-transformed Chinese hamster cells and chicken fibroblasts were studied. It was concluded that the first step for obtaining RSV in these mixtures was the agglutination of both types of cells with Sendai virus. Pretreatment of the cells with neuraminidase prevented virus rescue. Agglutination with phytohemagglutinin instead of Sendai virus did not result in virus rescue. (M.M.B.)

2844 INACTIVATION AND REPAIR OF POLYVALENT STAPHYLOCOCCUS PHAGES AFTER U. V.- OR GAMMA-IRRADIATION OR ACRIDINE ORANGE TREATMENT. Pillich, J.; Janovska, E.; Vizdalova, M. (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 15: 549-55(1969).

The influence was studied of changes of the bacterial host strain on the course of inactivation of Staphylococcus phages A/5 and ϕ131 after uv irradiation, γ irradiation, and photodynamic inactivation by acridine orange (AO). Effectiveness of phage plating was alike on all the host strains used. An influence of the various bacterial host strains on the survival of inactivated phages was found for uv-irradiated phages only. The bacterial host strains could be divided into strain groups having a favorable effect on the inactivation course of uv-irradiated phages, i.e., increasing the number of surviving phage particles, and into bacterial strains that may further reduce the survival of inactivated phage particles. The possible presence of repair mechanism in Staphylococcus bacterial cells is discussed. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 2579, 2690, 2832, and 2839.

2845 (NYO-3733-5) MICROBIOLOGICAL ASPECTS OF RADIOPASTEURIZED CHICKEN. Fifth Quarterly Report. (Hazleton Labs., Inc., Falls Church, Va.). June 12, 1968. Contract AT(30-1)-3733. 35p. Dep. CFSTI.

There were no major deviations from the expected growth responses of the various microorganisms inoculated onto chicken samples. The psychrotrophs developed into a major population, except in the single case when no irradiation was applied and samples were incubated at 70°F. The high coliform count indicating growth of these species may have influenced the development of the psychrotrophs, and the psychrotrophs were recorded as greater than values, which indicated the values plotted were the minimal value detected. The data indicate that the coliform titer was higher than the psychrotrophs. It appears that irradiation would prevent the high coliform count by reducing this group to a greater extent than the psychrotrophs. The yeast contribution to the psychrotrophic inoculum with its relative radioresistance is sufficient to permit continual growth of this group. (auth)

2846 (RLO-1730-3) STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS INVOLVED IN THE IRRADIATION OF MARINE PRODUCTS. Final Report, October 1, 1965-September 30, 1968. Liston, J.; Matches, J. R. (Washington Univ., Seattle. Coll. of Fisheries). Mar. 31, 1969. Contract AT(45-1)-1730. 104p. Dep. CFSTI.

Irradiation has been shown effective in reducing the number of spoilage bacteria in seafood products, thereby increasing the storage life of these perishable products. Bacteria are responsible for spoilage of seafoods. The flora responsible for spoilage of irradi-

ated products is different from that responsible for spoilage of non-irradiated products. This difference is due partially to irradiation and partially to packaging. Non-irradiated seafoods contain a mixed Gram negative flora that at the time of spoilage has shifted to predominately an active Pseudomonas flora. In irradiated products the mixed Gram negative flora, that is radiation sensitive, is virtually eliminated and replaced by the less radiation sensitive Achromobacter and Lactobacilli. As a result of these differences in flora, the biochemical patterns are also different. The shift is from the active oxidative organisms producing much volatile base in nonirradiated products to facultative relatively inactive organisms with much decreased volatile base-producing capability in irradiated products. The size of the dose and the time of application is important, however; irradiation is most effective when applied to very fresh fish even at very low dose levels but is ineffective as a treatment for spoiled fish. Two low doses applied at an appropriate spaced interval provide longer shelf life extension than a single dose equal to the sum of the two small doses. Organisms isolated from irradiated fish show greater average resistance to irradiation than organisms from non-irradiated fish due to elimination of sensitive strains. However, no buildup of radiation resistance was seen among survivors in seafoods subjected to multiple dose treatments. The radiation resistance varied with the stage of growth, being greatest during the stationary phase and least during the late lag and early log phases. Vibrio parahaemolyticus was isolated from shellfish, sediments, and market samples. These organisms, although present on seafoods, can be eliminated by low-dose irradiation. There is some variation in radiation sensitivity depending upon the suspending medium. The greatest destruction was obtained in peptone water followed by fish homogenate and crab meat. Salmonella, which have an optimum temperature of about 37°C, can also grow at much lower temperatures. It was grown at 5.9°C in pure culture in broth and at 8°C in mixed culture on fish tissue. Growth of Salmonella on seafoods and in culture medium at low temperatures is influenced by the salt concentration. The organisms are able to grow at 37°C in the presence of high levels of NaCl but as the incubation temperature is lowered the organisms fail to grow except at low salt concentrations. (auth)

2847 CURRENT ACTIVITIES AND FUTURE PROGRAMME ON FOOD IRRADIATION AT PHILIPPINE ATOMIC ENERGY COMMISSION (PAEC). Valencia, Iluminado G. Food Irradiat., 9: No. 4: 41-6(Apr.-June 1969).

A research program for the preservation of food products using the Philippine Atomic research center facilities is outlined. Of principal importance are shelf life of fruits and vegetables, radiosensitivity of indigenous microorganisms, changes in the nutritive values of irradiated foods, disinfestation of stored grains, and shelf life of processed meat products. Preliminary findings employing γ radiation are reported. (H.B.G.)

2848 ACTION OF MODERATE PRELIMINARY HEATING ON THE GAMMA RAY SENSITIVITY OF MOULD SPORES. Poisson, J.; Cahagnier, B. (Commissariat a l'Energie Atomique, Cadarache, France). Food Irradiat., 9: No. 4, 23-33(Apr.-June 1969).

Sweet corn contaminated with Penicillium cyclopium, Penicillium notatum, Cladosporium cladosporioides, and Aspergillus flavus was irradiated with 150 krad of cobalt-60 γ at various temperatures and for various periods of time. Heating to 50°C for 1 hr during exposure practically eliminated fungal contamination. Effects on the nutritional quality of the corn was not ascertained. (H.B.G.)

2849 COMPLEMENT TO PROGRESS OF FOOD IRRADIATION WORK, 1968. Food Irradiat., 9: No. 4, 2-18(Apr.-June 1969).

Research programs and preliminary results concerning food preservation by γ radiation were summarized for the following countries: Austria, Belgium, France, and Spain. Experiments with laboratory animals were conducted. It was concluded that more experimental work must be performed before the technique can be industrially applied. (H.B.G.)

2850 SYNERGISTIC EFFECTS OF GAMMA RADIATION AND HEAT ON THE DEVELOPMENT OF PENICILLIUM DIGITATUM IN VITRO AND IN STORED CITRUS FRUITS. Barkai-Golan, Rivka; Kahan, R. S.; Padova, R. (Volcani Inst. of Agricultural Research, Bet Dagan, Israel). Phytopathology, 59: 922-4(July 1969).

Combined treatments of heat plus γ radiation were investigated in an attempt to reduce the radiation dose required for control of fungi in stored citrus fruit. The effect of γ radiation and a hot-water dip on the viability of Penicillium digitatum spores in vitro, and on rot development in inoculated oranges and grapefruit, was compared with each treatment when applied separately. P. digitatum is one of the main pathogens of stored citrus fruit. Combined treatment of 25 to 100 Krad ^{60}Co γ irradiation and heating at 45 to 50°C synergistically reduced viability of the spores. There was an inverse relation between the percentage of viable spores and an increase in radiation dose or temperature. The storage life of inoculated Shamouti oranges and grapefruits held at 14°C was increased by the combined treatments more than by each treatment alone. The lowest radiation doses were most effective when employed as part of a combined treatment. Thus, a combined treatment of 50 Krad γ radiation and 52°C temperature for three or five min prolonged the appearance of rot on oranges by 18 days. Increasing the radiation dose to 100 Krad did not improve, and even gave poorer results, than the combined treatment using 50 Krad. (BBB)

2851 EFFECT OF RADIATION ON ETHYLENE PRODUCTION AND RIPENING OF BANANAS. Khan, Ismail; Muhammed, Amir (Atomic Energy Centre, Lahore). Food Irradiat., 9: No. 4, 34-40(Apr.-June 1969).

When bananas of the Basri variety were irradiated with low doses (15 to 35 kR) of γ radiation, there was little or no effect on ethylene production and no delay in ripening of the fruit. Higher doses (50 to 100 kR) stimulated ethylene production as well as hastening the ripening of the bananas. It is concluded that γ radiation cannot be used to extend the shelf-life of bananas of the Basri variety. (auth)

2852 FREEZING AND IRRADIATION OF FISH. Conference Held at Madrid, Spain, September 4–8, 1967. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969. 538p. (In several languages). (CONF-670992).

Separate abstracts were prepared for 18 papers presented on preservation of fish products by irradiation. Approximately 60 additional papers are included on various aspects of frozen fish products. (H.L.W.)

For abstracts of individual papers see: 2579, 2690, 2841, and 2853–2867.

2853 QUALITY INDICES THAT CAN BE USED TO ASSESS IRRADIATED SEAFOODS. Spinelli, J.; Pelroy, G.; Miyauchi, D. pp 425-30 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

Tests for objectively assessing the quality of irradiated fish were divided into two classes: those that correlated with sensory changes that occurred during storage and were therefore applicable in objectively testing irradiated fish, and those that showed poor correlation with sensory changes and were not particularly applicable in assessing the quality of irradiated fish. Total bacterial counts, volatile acid numbers, nucleotides, hypoxanthine, and extractable myofibrillar protein in fish showed the best correlation with sensory changes in irradiated fish stored at 33°F (0.5°C). Trimethylamine (TMA) did not correlate with sensory changes in fish irradiated at doses above 0.15 MRad; at doses below 0.15 MRad TMA showed fairly good correlation with sensory changes. Changes in histamine, low-molecular-weight carbonyls, thiobarbituric acid number, and free ribose in fish did not correlate with sensory changes in irradiated fish stored at 33°F (0.5°C). (auth) (UK)

2854 QUALITY ASSESSMENT AND CONSUMER ACCEPTANCE OF IRRADIATED SEAFOODS. Shewan, J. M.; Hobbs, G. pp 431-3 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

The quality assessment of irradiated sea foods by analytical taste panel techniques shows that the outstanding sensory feature of such products is the presence of burnt or singed odors and flavors associated probably with the production of organic sulfides. Few large-scale consumer tests of irradiated seafoods appear to have been carried out, apart from the use of products such as haddock and cod fillets in meals at United States Army Camps. (auth) (UK)

2855 GAMMA IRRADIATION TRIALS ON FRESH FISH AND SMOKED HERRING FILLETS STORED AT DIFFERENT TEMPERATURES. de la Sierra Serrano, D. pp 434-45 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969. (In Spanish).

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

Biological and physico-chemical assays on 200 samples of fresh

fish fillets and salted and non-salted smoked herring showed that irradiation at 0.2 to 0.35 MRad doses prolongs three or four times the shelf life of the product, provided that temperatures of 0 to 1°C (32 to 34°F) are maintained. Samples subjected to identical doses but stored at 6 to 8°C (43 to 46°F) had a shelf life of no more than two or three times that of products not irradiated. A 175,000 Ci mobile industrial irradiation unit having a ^{137}Cs source, was used for the irradiations. Microbiological analysis before and after irradiation demonstrated the advantages of irradiation as a pasteurization technique for fish fillets. These are frequently found to be contaminated with saprophytes, some of no serious hazard, others of a faecal origin, and some that are pathogenic, from the hands of workers or the utensils employed. Initial microfloral counts of 10^5 to 10^6 pathogens/cm^2 were reduced to the 10^3 to 10^5 range, depending on the dose. Culture media, selective or otherwise, on which many groups of micro-organisms were first isolated and subsequently identified, were developed, revealing that the predominant microflora in the fish, Achromobacter and Pseudomona, can be virtually destroyed at the irradiation doses mentioned. A residual microflora, consisting of species more resistant to radiation, such as the yeasts, Micrococci, Sarcina and Bacilli, are mostly saprophytic, developing after irradiation and replacing the initial microflora. Depending on the provenance of the fish, different quantitative equilibria in the bacterial flora were encountered, while the equilibrium of the various types remained constant. The findings confirm, for the most part, those of other authors that have worked on fish irradiation. Detailed analysis of micro-organisms may give an idea as to the sources of contamination, so that it will be possible to limit this even before the new technique is brought into use. A contribution is offered to research on the different factors (temperature, container, micro-organisms, dose and irradiation conditions) affecting the preservation of fish, and to achieving the best possible conditions for realizing the great potentialities opened up by irradiation in the preservation of fisheries products. (auth) (UK)

2856 EFFECT OF IRRADIATION ON THE KEEPING QUALITY OF PACKAGED COD FLESH. van Mameren, J.; van Spreekens, K. J. A.; Houwing, H.; Mosel, D. A. A. pp 446-8 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

Experiments in irradiation of ground fillets from fresh cod (Gadus morhua) packed in cellophane or vacuum-packed in Rilsan are described. Radiation doses of 0.15 to 0.25 MRad were used without producing off-flavors or off-colors. When stored at 2°C (36°F) the irradiated samples vacuum-packed in Rilsan kept much longer (26 vs 15 days) than those packed in cellophane. Total Volatile Bases (TVB) and aerobic plate counts were good spoilage indicators for both irradiated and nonirradiated samples packed in cellophane (not vacuum-packed), while Total Volatile Acids (TVA) appeared to have little value. For the nonirradiated vacuum-packed samples TVA, TVB, and aerobic plate counts all appeared to be good indices. For the irradiated vacuum-packed samples only aerobic plate counts, and to a lesser extent TVA, seemed to be useful. (auth) (UK)

2857 EFFECT OF IRRADIATION ON ANISAKIS LARVAE IN SALTED HERRING. van Mameren, J.; Houwing, H. pp 451-3 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

Experiments are described to test the practicability of using irradiation to kill Anisakis marina larvae in lightly-salted herring (Clupea harengus). The lower salt concentration used of recent years for the preservation of gibbed herring is insufficient to kill the parasites which may be harmful to the consumer. The nematodes were subjected to irradiation, either in water or saline suspension, or pressed between salted herring fillets or in situ in salted gibbed herring. The results were disappointing. In aqueous suspensions, a salt concentration of 6% and a dose of 1.0 MRad resulted in 100% kill, but appreciable numbers survived (although many of these were inactive) at lower irradiation dosages and at lower salt concentrations. It was noted that for doses of either 0 or 0.3 MRad the highest proportion of survivals occurred in 3% salt solutions. In testing the effect of irradiation on parasites in the fish, or placed between fillets, the dosages were limited, because of flavor and color changes, to 0.3 MRad for salted ripened herring, and 0.6 MRad for five-day-old lightly-salted herring. Substantial numbers of nematodes survived these doses. (auth) (UK)

2858 IRRADIATION INACTIVATION OF FOOD INFECTION MICRO-ORGANISMS IN SEAFOODS. Anderson, A. W. pp 454-62 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

Studies were conducted under controlled conditions in order to observe the resultant survival patterns of strains of pathogenic food contaminants in crab meat (Cancer magister), shrimp meat (Pandalus jordani), oyster meat (Crassostrea gigas), salmon (Oncorhynchus) and Hartsell's broth after exposure to ^{60}Co irradiation. The organisms used included the following: Salmonella; S. typhi, S. paratyphi A, S. paratyphi B, S. choleraesuis, S. enteritidis, S. pullorum, S. wichita, Shigella dysenteriae, Shigella paradysenteriae, Shigella sonnei, Escherichia coli, Streptococcus faecalis, Proteus vulgaris, Neisseria catarrhalis and Mycobacterium smegmatis. Each species was exposed to a series of irradiation levels from 0.05 to 1 MRad in the above seafoods and growth medium. The food mediums used were prepared from commercially canned crab and from fresh raw shrimps, oysters and salmon. Each sample was test inoculated with approximately 1×10^6 micro-organisms per gram. The results were plotted and the levels required for pasteurization determined. There was considerable variation in the survival patterns, depending upon the substrate and the micro-organisms. A tailing off was observed in the survival patterns of S. paratyphi A, S. pullorum, S. enteritidis, S. typhi, S. choleraesuis, Staphylococcus aureus and Streptococcus pyogenes in all the seafoods, but not or only slightly apparent in Hartsell's broth. Apart from Staphylococcus aureus and Streptococcus pyogenes, Salmonella typhosa, Salmonella paratyphi B, Salmonella wichita and Salmonella choleraesius were the most resistant of all the pathogens tested. The tailing off phenomenon was very marked in some of the seafood products. By the use of enrichment techniques the more resistant Salmonella could be recovered at 1 MRad. The D values were determined in each case. The results indicate that predicted pasteurization doses based upon D values would be inaccurate if based on the inactivation curve or if determined on one substrate. Each product would have to be examined and dose levels determined. (auth) (UK)

2859 EFFECTS OF MULTIPLE DOSE OF IRRADIATION ON THE BACTERIAL FLORA OF SEAFOODS. Liston, J.; Dollar, A. M.; Matches, J. R. pp 463-6 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

Pasteurizing radiation is effective in increasing the shelf life of fish held under refrigeration. Effectiveness is greatest for fresh fish with a low bacterial count and diminishes to a low level as fish become more spoiled prior to irradiation. Double dose treatments (using 50 + 50 kRad or 50 + 100 kRad) of fresh fish spaced at seven days gave a shelf-life extension equivalent to higher single dose treatments up to 300 kRad. As with single dose irradiation there is minimal extension of storage life by double dose treatment of spoiling fish, and eight to ten days' normal storage in ice prior to treatment appears to represent the absolute limit. Double dose irradiation treatment thus cannot be used to conceal the true bacterial quality of spoiled fish. Double dose irradiation shows promise as a practical technique for using shipboard irradiation. (auth) (UK)

2860 COMPLEMENTARY EFFECT OF FOOD PRESERVATIVE AND GAMMA RADIATION TREATMENT OF WHALE AND HORSE MACKEREL FLESH. Tomiyama, T.; Jeng, S. S.; Shiraishi, E.; Hamada, M.; Yamada, Y. pp 472-5 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

The effect of chemical preservatives (furylfuramide and chlortetracycline) in reducing the irradiation dosage required to extend the shelf life of whale and horse mackerel (Trachurus japonicus) flesh was investigated. It is reported that while these preservatives are completely inactivated in aqueous solution by 0.1 MRad they are protected to some extent in the presence of the fish flesh. The combined effect of the chemical preservative treatment and irradiation appears to be synergetic rather than additive, and a greater preservative effect is obtained if the chemical treatment precedes the irradiation. The investigations also indicated that 0.2 MRad irradiation can control the B. subtilis spores remaining in inoculated and tylosin-treated whale meat after a mild cooking. (auth) (UK)

2861 STATUS OF RESEARCH ON IRRADIATED FISH AND SHELLFISH IN THE UNITED STATES. Ronsivalli, L. J.; Kaylor, J. D.; Slavin, J. W. pp 482-7 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

The status of technical and commercial research on radiation-pasteurization of fish and shellfish in the United States is reviewed, and the following are discussed: the results of laboratory studies on organoleptic, microbiological, and wholesomeness aspects of irradiated seafoods; developmental investigations on irradiating fish ashore and at sea; and application of the process under commercial conditions. Research in many laboratories has shown the efficacy of the process, which extends the product shelf life by one to two weeks and reduces the total plate count by one to three log cycles. Other factors which affect the product shelf life and the composition of the microflora in the product (storage temperature, initial product quality, packaging, bacteriostatic salts, and oxygen availability) are discussed. Fish irradiation at sea appears advantageous. Irradiated spoiled product is compared with nonirradiated spoiled product, and a concept for determining whether a botulism hazard exists in radiation-pasteurized fish is described. The authors believe that radiation-pasteurized fish are as safe and wholesome as untreated fresh fish. Studies to test the commercial applicability of the process, using a 250,000 Ci ^{60}Co irradiator at Gloucester, Massachusetts, showed the process is efficacious and would be extremely valuable to industry. A survey indicated probable consumer acceptance of irradiated foods. Using commercial packing and shipping methods, it was found that radiation-pasteurized fish can be handled in the same manner as fresh fish, and the extended shelf life made possible with irradiation permits shipments to very distant points in the country. Results obtained by cooperating members of the industry representing about 9,000 retail markets indicate that irradiation will reduce waste and price cutting, increase sales and expand markets for fresh seafoods, result in overall higher quality products and lower costs for the consumer, and will increase profits for industry. (auth) (UK)

2862 PRESENT STATUS OF RADIATION PRESERVATION OF FISH AND FISHERY PRODUCTS IN EUROPE. Hobbs, G.; Shewan, J. M. pp 488-94 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

The potential applications of radiation pasteurization of fish are discussed in the light of feasibility, cost and potential health hazards. There are areas, such as the marketing of unfrozen packaged fish, where radiation could be used to advantage within the present marketing systems existing in Western Europe. The potential increase in hazard from botulism requires a more critical examination, however, before such a process would be acceptable. Another promising application is in the decontamination of imported fish meals. While radiation sterilization is not yet a feasible process, further research may lead to the development of a suitable process in combination with heat and chemical additives. (auth) (UK)

2863 IRRADIATION OF FISH PRODUCTS. SPANISH POSSIBILITIES. de la Sierra Serrano, D. pp 495-8 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969. (In Spanish).

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

The possibilities of using irradiation as a preservation method for seafood in spain are reviewed in the knowledge of international experience. The favorable conditions which exist for the implementation of a National Plan for Seafood Irradiation are stressed and the stages that have to be followed are outlined. (auth) (UK)

2864 ITALIAN EXPERIENCE IN RADIOPASTEURIZATION OF FISHERY PRODUCTS. Massa, D.; Perna, A. pp 499-500 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969. (In French).

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

The possibilities of using irradiation in Italy as a preservation method for seafood are briefly described, and results of bacteriological and taste panel tests on Mediterranean hake irradiated at a level of 0.3 MRad are reported. Irradiation can increase the shelf life of refrigerated seafoods to an extent that might affect favorably Italian market conditions. (auth) (UK)

2865 ECONOMIC FEASIBILITY OF RADIOPASTEURIZATION OF FISH. van Meir, L. W. pp 504-8 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

Radiopasteurization of fish is reviewed with regard to its potential to reduce the overall costs of processing and distribution, and to enable industry to increase the demand for fish. Industry must be able to anticipate sufficient financial gains from either or both of these factors before bearing the risk of investing the capital necessary to adopt radiopasteurization. On the basis of preliminary data it appears that radiopasteurization offers some potential for decreasing costs and a great potential for increasing demand for the fresh product form of several species of fish. The question of implementing radiopasteurization gives rise to many problems of a nature that will have to be considered not only by industry but by governments. These problems will require additional study and policy determination, as well as technical research to provide adequate knowledge for policy formation and program development. (auth) (UK)

2866 IRRADIATION OF FISH AT SEA. Carver, J. H.; Connors, T. J.; Slavin, J. W. pp 509-13 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

An engineering study has shown that it is possible to irradiate fish at sea, and several commercial shipboard irradiators have been designed. An experimental irradiator was built and installed aboard the M.V. Delaware in 1966. This first shipboard irradiator weighs 15.8 t, stands 2.7 m high and occupies a floor space of about 1.7 m^2. It contains a 27,000 Ci ^{60}Co plaque in a cask of steel and lead that is 22.8 cm thick, has a dose delivery of about 10 kRad/min, and has a throughput of 100 kg of fish products per hour at a dose level of 100 kRad. To date the unit has been used to radio-pasteurize surf clams (Spisula solidissima), haddock (Melanogrammus aeglefinus), herring smelt (Argentina silus) and codfish (Gadus morhua). The shelf life of these products was doubled or tripled. Such vessels holding unfrozen fish will be able to stay at sea for longer periods, increasing the possibility of returning to port with full loads. Prerigor fish appear to be more suitable for irradiation than post-rigor fish. Otherwise, no quality differences were found. Pasteurization at sea can apparently be accomplished with lower dose levels than are necessary in land-based operations. No problems were experienced in operating the irradiator at sea. (auth) (UK)

2867 MEAT COLOUR REGENERATION IN FROZEN TUNA BY IRRADIATION. Amano, K.; Yamanaka, H. pp 514-15 of Freezing and Irradiation of Fish. Kreuzer, Rudolf (ed.). London, Fishing News (Books) Limited, 1969.

From Conference on Frozen and Irradiated Fish and Fishery Products, Madrid, Spain. See CONF-670992.

In spite of many efforts in the shipboard handling, discoloration of frozen tuna is unavoidable and causes unprofitable market price for the fish handlers who can find out the defect only after thawing. A known action of gamma irradiation to convert metmyoglobin to oxymyoglobin was examined as to the improvement of meat color of frozen tuna. Between 0.2 and 1 MRad dosages the grade of color regeneration in terms of metmyoglobin percentage was 37 to 39% after irradiation of a discolored tuna containing 75% of metmyoglobin, and the fish were judged bright red organoleptically. However, irradiation higher than 0.2 MRad was found not practical, because of the developed off-flavor. A more important problem noticed was reversible formation of metmyoglobin in comparatively short time even under freezing conditions. Further studies are needed to prolong the regenerated meat color. (auth) (UK)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 2410 and 2411.

2868 (ORNL–4470) METALS AND CERAMICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1969. Peterson, Sigfred (comp. and ed.) (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 246p. Dep. CFSTI.

Progress during the year is summarized in forty sections. A separate abstract was prepared for each of thirty-nine sections. The section for which no abstract was prepared contains information on miscellaneous activities. (J.R.D.)

For abstracts of individual sections see: 2341, 2407, 2417, 2869, 2870, 2877, 2892–2896, 2915–2923, 2940–2945, 2971, 2975, 2978, 2981–2984, 3002–3004, 3024, 3025, and 3048.

2869 (ORNL–4470, pp 213-17) METALLOGRAPHY. Gray, R. J. (Oak Ridge National Lab., Tenn.).

The alpha metallography facility has operated satisfactorily for almost a year. Photomacrography attachments have been added to the metallograph. Two glove boxes have been added to provide low-power photomacrography and microhardness testing. Electron microprobe analysis continues to be a prime research tool. A shielded electron microprobe analyzer has been installed for the analysis of highly radioactive specimens. A proper setting of the threshold control, correct choice of magnification, and the selection of a sufficient number of fields are very important for analyzing minute microstructural features. Hot-stage microscopy has been used to a definite advantage, and a résumé was issued on new equipment and techniques in the field. (auth)

2870 (ORNL–4470, pp 218-21) NERVA PROGRAM METALLURGICAL SUPPORT. Clausing, R. E. (Oak Ridge National Lab., Tenn.).

Several eddy-current probes have been designed, built, and tested for nondestructive inspection of coolant channels in beryllium reactor components. These probes have demonstrated the feasibility and usefulness of the inspection techniques and may be used as prototypes for quality control instruments. Outgassing of NERVA fuel elements is being measured under conditions similar to those expected in space operations; the rates for 11 different gases can be determined semicontinuously during each test run, and the results can be analyzed and plotted as a function of time and temperature with the aid of a computer. The emphasis of the adhesion studies has been shifted to the effects of shear motion on adhesion in controlled vacuum environments. (auth)

2871 REACTIVITY OF SOLIDS. Proceedings of the 6th International Symposium, Schenectady, New York, August 25–30, 1968. Mitchell, J. W.; DeVries, R. C.; Roberts, R. W.; Cannon, P. (eds.). New York, Wiley-Interscience, 1969. 870p. (In several languages). (CONF-680833).

Seventy-nine papers were presented at the conference. Separate abstracts were prepared for each of seventeen papers. Papers for which no abstracts were prepared are concerned with aspects of processes in chemical reactions involving solids, growth of new phases in the solid state, thermal decomposition reactions of inorganic compounds, reactions of solids with gases and solutions, production of crystalline solids from gaseous reactants, chemical reactions between crystalline solids, chemical reactions in vitreous systems, and chemical responses in high-pressure systems. (J.R.D.)

For abstracts of individual papers see: 2879–2882, 2924, 2951, 2979, 2987–2990, 3008, 3009, 3032–3034, and 3055.

2872 REVIEW OF REMOTE OPTICAL METALLOGRAPHY. Krautwedel, H. L. (Nuclear Research Center, Karlsruhe, Ger.). Metallography, 2: 191-208(Sept. 1969).

The present status of remote optical metallography is reviewed. A brief description of facilities, equipment, and preparation technique is given. Although hot cell design and construction are not included, a complete outline of equipment and technique is presented. (auth)

2873 REACTOR MATERIALS. Volume 12, Number 4. Simons, E. M.; Keller, D. L. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Institute, Winter 1969–70. 36p. GPO $0.70.

Research progress is reviewed in three sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 2898, 2930, and 2976.

2874 CONTINUOUS COMPILATION OF NEW REFERENCE DATA ON DIFFUSION PROCESSES IN INORGANIC SOLIDS AND THEIR MELTS. Diffus. Data, 3: 261-3(Sept. 1969).

Reference data are included on diffusion in solid metals and alloys, molten metals and alloys, intermetallic compounds, oxides, halides, and in miscellaneous substances. (J.R.D.)

Corrosion and Erosion

Refer also to abstracts 2908, 2911, 2917, and 2996.

2875 (BNWL–1075) SODIUM FLOW TEST OF 7-ROD CLUSTER IN SODIUM COMPONENTS EVALUATION LOOP (SCEL). Millhollen, M. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1969. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

A flow test was conducted in which a short, 7-rod fuel cluster, contained within a hexagonal flow duct was subjected to flowing 1060°F sodium for 9000 hr. Velocity of flow over the 304 SS cladding and wire wrap spacers varied from 25 ft/sec at the beginning of the test period to 30 to 31 ft/sec at the end. Interim visual examinations were performed when convenient, and a destructive examination of cladding and spacer wire of one rod was conducted after the test. No unusual wear or severe damage was noted at any location. Minor surface damage to both cladding and wire wrap allowed penetration of sodium along grain boundaries to a depth of approximately 0.001 inch. (auth)

2876 (CEA-CONF–1299) BEHAVIOR OF STAINLESS STEEL IN PLANTS FOR THE PROCESSING OF IRRADIATED FUEL. Pelras, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1968]. 35p. (In French). (CONF-681218–2). Dep. CFSTI (U. S. Sales Only).

From Conference on Nuclear Corrosion, Paris, France.

The various forms of corrosion of stainless steels of the 18/10, 17/13 Mo, and 25/20 type with low carbon contents were examined in a bibliographic study. These included the generalized corrosion and intergranular corrosion. The corrosive effect of the nitric and hydrofluoric media and the effect of Mo on the corrosion behavior were also studied. The potential intensity curve of stainless steel in nitric acid had three parts: the cathode branch, the passivity zone, and the anodic branch. As stainless steel was usable only in the passivity zone, the principal parameters which displaced the potential of the steel toward the two corrosion zones were examined. Some examples are given of corrosion in the transpassivity zone. The effect of hexavalent chromium and trivalent iron was outlined. The coupling effect with gold and graphite is also discussed. The corrosion in the cathode x zone was discussed with a consideration of the effects of Ni, Cr, Si, and temperature. (J.S.R.)

2877 (ORNL–4470, pp 68-75) ALKALI-METAL CORROSION OF HIGH-TEMPERATURE MATERIALS. DeVan, J. H.; Litman, A. P. (Oak Ridge National Lab., Tenn.).

Examination of published oxidation results for vanadium–titanium and vanadium–aluminum alloys in sodium showed that the reaction kinetics is consistent with an internal oxidation model in which solid-state diffusion of oxygen into the alloys controls the rate of oxide precipitation. At 550°C unalloyed vanadium picked up oxygen at 0.5 ppM/hr at 2×10^{-6} torr O and 0.1 ppM/hr at 2×10^{-7} torr. In static capsule tests at 600 and 800°C, sodium (50–1300 ppM O) did not penetrate vanadium containing up to 1900 ppM O. The vanadium gettered oxygen from the sodium, indicating a large equilibrium distribution coefficient. The compatibility of thermal insulation with stainless steel from 700 to 815°C in moist air was determined. No catastrophic oxidation of Type 316 stainless steel was found. Type 304L stainless steel was superior to Type 316 in scaling resistance. Temperature cycling effects on scaling were dependent on the thickness of the scale. More scaling occurred with asbestos-diatomaceous silica insulation than with alumina-silica blanket insulation. Hafnium, oxygen, and nitrogen were transported from hot-leg specimens in a T-222 thermal convection loop operated with lithium. Thermal aging and nitrogen pickup reduced room-temperature ductility in specimens exposed at 1270 to 1300°C. Fabrication of a T-111 forced-circulation lithium loop was completed and shakedown operations began. Weld tests of T-111 and T-222 conducted in conjunction with loop assembly showed no breakdown in corrosion resistance even at 500 ppM O contamination; however, weld heat treatment at 1300°C was required to eliminate base metal corrosion. Oxygen-induced attack of CVD niobium and arc melted W–25% Re was found in refluxing potas-

sium capsule tests at 1200°C. No attack of TZM or FS-85 was found in boiling potassium natural-circulation loops at 1250°C. Mass transfer was observed in the nozzle-turbine blade test section of a D-43 forced-circulation boiling potassium loop after 10,000 hr at a maximum temperature of 1200°C. Boiler and condenser regions of the loop showed negligible corrosion. The threshold oxygen concentrations in Nb or Ta for penetration by K, Na, and Li at 600°C were determined. Solution interaction parameters were used to characterize the effect of oxygen in Na and K on the dissolution of Nb and Ta. (auth)

2878 (ORNL-tr-2237) CORROSION BY POLLUTED SEA WATER AND ITS PREVENTION (EFFECT ON COPPER ALLOYS). Ikemura, Kyoichi. Translated for Oak Ridge National Lab., Tenn., from Boshogu Gijutsu, 11: No. 6, 250-5(1962). 17p. Dep. CFSTI.

The corrosive effects of pollutants which are particularly active against Cu alloys are discussed. Information is included on attachment of marine organisms to metal surfaces, and effects of sulfides from bacteria and algae. Preventive measures for minimizing corrosion of brass and Cu are described which include improvement of the properties of the metal and alloy and decreasing the seawater contamination. (J.R.D.)

2879 MASS SPECTROMETRIC INVESTIGATION OF THE SURFACE REACTION OF TUNGSTEN WITH CHLORINE–OXYGEN MIXTURES. McKinley, J. D. Jr. (National Bureau of Standards, Washington, D. C.). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 345-51(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Results of studies on the kinetics of chemical attack on hot W surfaces by O and Cl are discussed. In such reactions it appears that adsorbed Cl and O form an intermediate species which is a precursor for $WO_2Cl_2(g)$, $WO_2(g)$, and $WO_3(g)$. It is thought that zero order pressure dependence is due to a cover layer of adsorbed Cl and O on the reactive surface. It appears that O sticks to the surface more effectively than Cl requiring a larger partial pressure of Cl to saturate the surface and cause a decrease in reaction order. (J.R.D.)

2880 CORROSION OF METALS IN GASES AND AQUEOUS SOLUTIONS. Hauffe, Karl (Univ., Goettingen, Ger.). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 311-23 (1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

New results on metal oxidation are discussed and illustrated using selected examples. Discussions and information are included on corrosion of metals in gases, the fourth power rate law of oxidation, passivation and inhibition of metal oxidation, effects of electric fields on oxidation, local cell action during metal corrosion, and corrosion of metals in aqueous solution. (J.R.D.)

2881 EFFECT OF STRUCTURE ON THE MECHANISM OF ZIRCONIUM OXIDATION. Lightstone, J. B. (Union Carbide Co., Tonawanda, N. Y.); Pemsler, J. P. Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 615-30(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

A large volume fraction of potential short circuit paths for diffusion was shown to exist in the oxide formed on Zr by oxidation between 500 and 1000°C in oxygen. The results of oxygen tracer experiments were also in agreement with a short circuit diffusion mechanism of oxygen transport. The assumption of line diffusion was shown to imply intuitively reasonable values of both the grain boundary thickness and the ratio of the oxygen line diffusion coefficient to the lattice diffusion coefficient. (auth)

2882 CHANGES IN REACTION BEHAVIOR AND MORPHOLOGIC MODIFICATIONS ACCOMPANYING THE REACTIONS OF SULFIDATION AND OXIDATION OF CERTAIN POWDERED METALS. Barret, P.; Dufour, L. C.; Delafosse, D. (Faculte des Sciences, Dijon, France). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 507-21(1969). (In French).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

The changes in the kinetic regimes, observed in the oxidation of powdered tungsten, nickel, copper, and in the sulfidation with hydrogen sulfide of silver wires, are experimentally revealed by transformations of the rate equation, activation energy, and pressure law. The morphology of the solid product is also modified weakly or strongly according to the first or second species forming during these changes, which are obtained at the same temperature and the pressure more easily when the particle size is smaller. The experimental observations are interpreted by the participation of a variable number of partial processes which contribute, in steady state, to provide the migration of the reacting species through the interfacial boundaries and through the produced solid, rates of which become equal. The interpretation, of the second-stage changes of the kinetic regimes, implies a retarded germination rate, or occasionally a retarded recrystallization rate of an initial film, under the influence of vapor phase transport phenomena. (auth)

2883 MARKER TECHNIQUES FOR STUDYING THE MECHANISM OF SCALING OF METALS BASED ON THE USE OF THE $^{18}O(p,n)^{18}F$ NUCLEAR REACTION. Holt, J. B.; Himmel, L. (Univ. of California, Livermore). J. Electrochem. Soc., 116: 1569-80(Nov. 1969).

A general mechanistic approach to the study of scaling reactions is proposed which dispenses with the conventional inert marker. Instead, radioisotopes of the reacting components are used to establish the nature of the diffusing species in the solid reaction products formed on metal surfaces at high temperatures. For investigating the mechanism of oxidation of metals, ^{18}O is employed as a tracer and the stable isotope is subsequently activated by proton bombardment via the nuclear reaction ^{18}O, $(p,n)^{18}F$. The basis for the technique is outlined and its application to the scaling of iron and of zirconium is described. The experiments with iron establish conclusively that, at temperatures up to 1050°C, iron is the only diffusing component in the dense, adherent wüstite layer which forms adjacent to the metal. Direct evidence is also presented for the vapor phase transport of oxygen by a dissociative mechanism during the growth of porous, non-adherent wüstite scales on iron in H_2/H_2O atmospheres. It is shown that oxygen is mobile in thick ZrO_2 scales formed on Zr in water vapor atmosphere at 1200°C; however, the unusual form of the ^{18}O distribution in the scale indicates that open channels must have existed in the outer portion of the scale during oxidation which allowed direct penetration of oxygen to levels deep within the ZrO_2 layer. The advantages and limitations of the technique are discussed with particular reference to conventional marker methods. Major sources of difficulty in the interpretation of inert marker experiments are identified and a set of experimental requirements is given which, if satisfied, should permit reliable transport information to be obtained using conventional marker techniques. (auth)

2884 GAS PHASE TRANSPORT IN THE OXIDATION OF Fe AND STEEL. Surman, P. L.; Castle, J. E. (Central Electricity Research Lab., Leatherhead, Eng.). Corros. Sci., 9: 771-7(Oct. 1969).

A mechanism involving vapour-phase transport for the oxidation of Fe and mild steel in steam and in CO_2 is proposed. The mechanism is supported by scanning electron micrographs of mild steel oxidized in steam, and by thermodynamic calculations based upon Castle and Masterson's model for the aqueous oxidation of Fe. Preliminary data on Fe transport in CO and steam are also reported. (auth) (UK)

2885 EFFECT OF ADDITION AGENTS AND STRUCTURE ON CORROSION OF ZIRCONIUM ALLOYS IN HIGH TEMPERATURE WATER AND STEAM. Blanchet, J.; Coriou, H.; Grall, L.; Olivier, P.; Pelras, M. (CEA, Saclay, France). Energ. Nucl. (Paris), 11: 345-56(Aug.-Sept. 1969). (In French).

The corrosion behavior of Zr, Fe 1% Cu 1% and Zr, Fe 2% alloys was investigated in various metallurgical conditions, in steam at 500°C. The study of structures and of their evolution has helped to understand the kinetics of corrosion that were observed. The results indicated that the mechanisms of oxidation which take place in 500°C steam in 360°C water, and 400°C steam differ. (auth)

2886 HAFNIUM. II. OXIDATION. Vahldiek, F. W. (Air Force Materials Lab., Dayton, Ohio). J. Less-Common Metals, 19: 305-14(Dec. 1969).

The oxidation of hafnium was studied at 760 mm Hg oxygen pressure in the temperature range 600 to 1250°C using the thermogravimetric technique. A primarily linear oxidation rate was determined for hafnium from 600 to 800°C. For as-received hafnium, an activation energy of oxidation of 0.90 eV with the rate equation, $K_L = 2500\ e^{-10,400/T}$ was determined. For 3-pass electron-beam-melted hafnium, an activation energy of 0.42 eV with the oxidation rate equation, $K_L = 2.0\ e^{-4840/T}$ was calculated. High-temperature x-ray diffraction showed that oxidation results in the formation of monoclinic HfO_2 above 550°C in air and oxygen atmosphere. High-temperature electron microscopy studies showed preferential and random oxidation behavior of hafnium at a pressure of 10^{-5} mm Hg above 600°C. (auth)

2887 THE MECHANISM OF STRESS CORROSION FRACTURE OF A COPPER–BERYLLIUM ALLOY. Sylwestrowicz,

W. D. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Corrosion, 25: 405-15 (Oct. 1969).

The process of stress corrosion fracture was investigated in a copper-beryllium alloy specimen exposed to different ammonia environments. Two basically different stages occurred in this process. First, reactions led to the formation of a crack, then formation and propagation of the crack. In the first stage, dissolution was probably the main effect of the corrosive environment resulting in a preferential attack on grain boundaries or on crystallographic planes. The distribution of solutes determined the areas of preferential attack (grain boundaries of crystallographic planes) and it depended on the aging conditions of the specimens. Plastic deformation and applied stress were not important factors in this stage. In the second stage, during the formation and propagation of the crack, the amount of plastic deformation, the value of applied stress and distribution of solutes were important. The main effect of the corrosive environment, in this stage, consisted in the decrease of the surface free energy by a sorption process. Based on these observations a mechanism of stress-corrosion fracture in a copper-beryllium alloy specimen is proposed. (auth)

2888 THE EFFECT OF OXYGEN ON THE COMPATIBILITY OF NIOBIUM WITH POTASSIUM. Klueh, R. L. (Oak Ridge National Lab., Tenn.). Corrosion, 25: 416-22 (Oct. 1969).

Refractory metals are highly resistant to dissolutive corrosion attack by liquid and boiling alkali metals when the alkali metals and refractory metals are free of impurities. Dissolution increases drastically, however, when the alkali metals contain oxygen. This phenomenon has been attributed to the formation of ternary oxides containing atoms of the two metals. As an alternative to the ternary oxide hypothesis, the possibility that at equilibrium only two condensed phases are present and that the oxygen affects the solubility of the refractory metal by decreasing the activity coefficient of the refractory metal in the liquid was examined. The interplay between solute species in refractory metal-oxygen-alkali metal systems can be characterized in terms of interaction parameters. This approach was evaluated using data from the niobium-oxygen-potassium system at 600°C. The observed solubility of niobium as a function of the oxygen content in potassium was consistent with that expected on the basis of calculated interaction parameters. Analysis of the observed behavior in terms of the phase rule also indicated that only two condensed phases exist at equilibrium. (auth)

2889 IN-SITU GAMMA MEASUREMENT OF THE TRANSPORT OF RADIOACTIVE CORROSION PRODUCTS IN A SODIUM LOOP. McCown, J. J.; Maloney, E. H.; Shannon, D. W. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Radiochem. Radioanal. Lett., 2: 125-32 (Nov. 20, 1969).

A method is described for measuring the behavior of activated corrosion products in flowing sodium systems which is based on in-situ γ scanning. Both sodium iodide and lithium drifted germanium diode detectors have been utilized in studying the behavior of ^{51}Cr, ^{54}Mn, ^{58}Co, ^{59}Fe, and ^{60}Co in both pumped and thermal convection loop systems. Detector calibrations utilizing known disintegrations/min (d/m) solutions of one or more radionuclides contained in ten sizes of steel tubing, permitted the quantitative measurement of d/m/in.^{2} of loop tube surface. Several velocity change and migration effects were discovered which would be difficult if not impossible to measure by distinctive examination methods. (auth)

Preparation and Fabrication

Refer also to abstracts 2342, 2408, and 2985.

2890 (NLCO-1043) ROLLING OF URANIUM CONTAINING SMALL QUANTITIES OF IRON, SILICON, AND ALUMINUM. Hesselbrock, H. W. (National Lead Co. of Ohio, Cincinnati). Oct. 1969. Contract AT(30-1)-1156. 19p. Dep. CFSTI.

Three alloys of uranium (containing various combinations of iron, silicon, and aluminum in small quantities) and an unalloyed control sample were rolled in an experimental mill. The samples were rolled through four passes at initial temperatures ranging from 1000 to 1300°F. Roll separating forces were measured with strain-gage load cells, and the data were subjected to regression analyses. It was found that roll separating forces decreased linearly with increasing billet temperatures up to 1125°F. As the temperature continued to rise above that temperature, roll forces continued to decrease, but at a lesser rate, until the beta transformation temperature was reached. The response to deformation of the three alloys differed from that of the control sample. The results indicate that the use of a lower initial billet temperature in the production rolling mill would be advantageous. (auth)

2891 (NP-18050) REPORT ON EUROPEAN URANIUM ENRICHMENT. ANNEX I. ESTIMATION OF EUROPEAN REQUIREMENTS. ANNEX II. ECONOMIC ASPECTS OF URANIUM ENRICHMENT IN EUROPE. (Forum Atomique Europeen). Jan. 1969. 31p. Dep. CFSTI (U. S. Sales Only).

The contribution of nuclear power plants to the European electricity supply are given and the projected capacity and requirements to 1980 are discussed. The processes for the enrichment of uranium are summarized along with research and development progress of each country. The economic aspects of uranium enrichment in Europe with regard to each process are discussed. (J.C.W.)

2892 (ORNL-4470, pp 85-93) MATERIALS DEVELOPMENT FOR ISOTOPIC POWER PROGRAMS. Donnelly, R. G. (Oak Ridge National Lab., Tenn.).

Research and development on materials for encapsulation of isotopic power fuels is being carried out for space and terrestrial (including undersea) applications. Tungsten was preferentially lost from W-25% Re as a volatile oxide in the thermionic range of 1650 to 1950°C and 10^{-7} to 10^{-4} torr O_2, pressures expected from Cm_2O_3 fuel. Similar oxygen pressures drastically increased creep rates of tungsten and W-50% Mo, and stress enhanced sublimation. An analytical model to predict failure time of nonvented capsules containing alpha-emitting isotopes from conventional creep data was developed. Compatibility of capsule material with $^{244}Cm_2O_3$ is being tested at temperatures representative of various energy conversion devices. Tests for 1000 hr at 1650 and 1850°C were completed. Several alloys were developed for brazing tungsten for service at 1650°C under vacuum. Intricate tungsten test components and coated microspheres were prepared by chemical vapor deposition. Creep-rupture data were obtained for welds and tensile data for aged specimens of Haynes alloy No. 25. Welds were comparable to wrought material although failures were predominantly at the fusion line. A highly embrittling aging reaction was found at about 700°C, probably due to precipitation of β-Co_3W. The creep strength decreased in vacuum, particularly for thin specimens. Less volatile and more oxidation-resistant alloys are being investigated; they have ordered structures and high concentrations of noble metals. Type 316 stainless steel, Haynes alloy No. 25, and Hastelloy C capsules were compatible with nonradioactive $SrTiO_3$ and Sr_2TiO_4 up to 1100°C. Further investigation of these alloys with SrO is seeking the nature of an observed interaction. Electron-beam welding and ultrasonic inspection techniques were used for the SNAP-21 and SNAP-23 capsules. For the Isotope Kilowatt Program, thermoelectric conversion systems and conceptual design studies on a 3-kW thermoelectric converter were reviewed. A pellet-type converter using direct heat transfer from a tungsten fuel block shows the highest conversion efficiency of about 8%. (auth)

2893 (ORNL-4470, pp 112-17) JOINING RESEARCH ON NUCLEAR MATERIALS. Slaughter, G. M. (Oak Ridge National Lab., Tenn.).

The weldability of materials applicable to the fabrication of nuclear power plants is being investigated. Initial studies are centered on the weldability of alloys containing nickel ranging from the low percentages used in stainless steels to the large amounts represented by Inconel 600. Both weld metal and heat-affected zones are of interest. Sulfur in high-nickel alloys decreased hot ductility and drastically impaired recovery of ductility in the heat-affected zone after exposure to a peak temperature of 2450°F. Manganese did not improve the hot ductility but appeared somewhat detrimental. Phosphorus was not detrimental. Work on intermediate-nickel Incoloy 800 class of material has concentrated on intermediate temperatures (1400 to 1600°F). The presence of titanium is necessary if elevated-temperature ductility is to be restored after the alloy has undergone a ductility minimum. Titanium mainly enhances the propensity toward recrystallization. Both sulfur and phosphorus increased the hot-cracking sensitivity of weld metal in the high-nickel alloys of the Inconel 600 class. Adding Si, Mn, Al, or Ti decreased the propensity toward cracking. Minor variations in chemical composition affected the amount and distribution of ferrite in stainless steel welds, particularly for the chemical compositions tailored to provide specific ferrite percentages. An investigation of the effect of defects on the mechanical properties of weldments has begun. Weld discontinuities are being developed that simulate, both in size and location, those found in welds. (auth)

2894 (ORNL-4470, pp 141-4) ZIRCONIUM METALLURGY. Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.).

Most of the mechanical and physical properties of zirconium alloys depend strongly on crystallographic texture. For many applications, therefore, a particular texture is desired. Studies

of the fabrication and resulting textures in Zircaloy tubing are the basis of predictions concerning the texture produced by any fabrication sequence. Procedures used to yield a given texture may be specified based on design of dies and mandrels to most easily effect control. To determine factors influencing the development of texture during fabrication, the texture after each step in fabricating tubing by a variety of methods and variations was examined. Parameter charts that interrelate up to seven fabrication variables facilitate prediction and control of texture. In addition, annealing, when required, may be useful in tailoring texture. The biaxial yield behavior of Zircaloy tubing has been examined as a function of texture, and a method of predicting this behavior from texture data has been developed. (auth)

2895 (ORNL-4470, pp 145-7) DESALINATION. Slaughter, G. M. (Oak Ridge National Lab., Tenn.).

Metallurgical assistance to the Desalination Program was directed at both the Unclad Metal Breeder and a uranium-metal-fueled pressurized water reactor. Literature surveys on the materials problems were made for both projects. The Th–20 wt % U alloy for UMBR can be cast into a configuration containing sharp corners without cracking. Excellent structures of a type desirable for good irradiation performance were achieved. Physical property measurements were also completed on such alloys produced by various techniques. The powder metallurgy alloys varied widely in electrical resistivity. (auth)

2896 (ORNL-4470, pp 163-7) HIGH FLUX ISOTOPE REACTOR TARGET DEVELOPMENT. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

The Transuranium Project is producing quantities of the heavier transuranium elements for research by successive neutron captures in plutonium, americium, and curium. The irradiations are carried out in the High Flux Isotope Reactor. Target elements are removed periodically and reprocessed to obtain the product actinides and to recycle target actinides to the HFIR. Activities devoted to design fabrication and evaluation of target elements, and special target assemblies and sources are reported. The remote fabrication line and encapsulation equipment were operated to produce targets, hydraulic rabbits, and sources containing ^{242}Pu, ^{244}Cm, ^{253}Es, and ^{252}Cf. Difficulties were encountered with the remote equipment, but suitable improvements were made to meet the necessary schedules and performance standards. Targets containing ^{242}Pu that had been irradiated in only the HFIR performed satisfactorily for 17 full cycles in the HFIR, accumulating fluences ranging from 8.2 to 9×10^{22} neutrons/cm^2 (>0.81 MeV) and attaining 42 to 46% FIMA at the midplane. This is both a higher level of burnup and fast flux exposure than was experienced by the targets that failed after irradiation in both Savannah River and HFIR. The causes of low-ductility failures in the HFIR targets and alloys more suitable for cladding use were investigated. A failure model used to predict the target life will be extended with more porosity available in the pellets. At present, seven targets in the HFIR have been irradiated for over two years. Six low-density targets have achieved a burnup of approximately 62% FIMA. One of the original targets that had not been irradiated in Savannah River Reactor has been irradiated to 70.5% FIMA without failure. (auth)

2897 (RMI-13) SEMI-ANNUAL PROGRESS SUMMARY, JANUARY–JUNE 1969. (Reactive Metals, Inc., Ashtabula, Ohio). Sept. 26, 1969. Contract AT(30-1)-1405. 58p. Dep. CFSTI.

Research and development progress are reported on upset forging of Alloy 801 and on double forging to reclaim faulty billets. Other work is reported on fabrication of internally and externally cooled elements by extrusion and or oxidation of U to prevent galling during extrusion. Information is also included on improved extrusion lubrication, development of methods for promoting duplexed grain structure in extruded Mark 30 overstock, and on precision extrusion processes for Mark 30 geometries. (J.R.D.)

2898 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 12: 248-56 (Winter 1969-70).

Methods used in fabrication of powder metallurgy materials are reviewed. Information is included on melting, casting, chemical plating, explosive forming, welding, and brazing. Information is also included on nondestructive testing. (J.R.D.)

2899 POWDERED TUNGSTEN CUTS COST OF AUTOMOTIVE CONTACTS. Soderholm, Lars G. Des. News, 24: 60 (May 12, 1969).

Tungsten powder metal contacts are produced with very low material loss using a new 95 to 96% density powder and close tolerance tooling. Tungsten dioxide is reduced to pure metal in a furnace and a binder is added for strength during press compacting. The binder is removed before high-temperature sintering and the contact is then deburred, polished and brazed to a backing. (Metals Abstr.)

2900 CONDITIONS OF CRYSTALLIZATION AND PROPERTIES ON HIGHLY DISPERSED SILVER-MOLYBDENUM POWDER. Trotsenko, V. I.; Loshkarev, Yu. M. (Dnepropetrovsk State Univ., USSR). Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 1-4(Sept. 1969). (In Russian).

The conditions are studied for obtaining highly dispersed silver-molybdenum powder by electrolysis of water solutions with subsequent reduction annealing. It is established that during combined reduction of silver and MoO_4^{2-} ions on the cathode the reduced slightly-soluble compounds of molybdenum of intermediate valency precipitates on the facets of growing silver particles forming high-dispersed friable sediment. The cathodic sediment consists of submicroscopic fine arborescent particles, which do not recrystallize when electrolysis stops. (auth)

2901 INVESTIGATION OF THE PROCESS OF NIOBIUM POWDER COMPACTION DURING HOT PRESSING. Kovalchenko, M. S.; Petrykina, R. Ya.; Samsonov, G. V. (Inst. of Problems of Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 5-9(Sept. 1969). (In Russian).

The process of hot pressing of niobium powder is investigated. It is shown that the compaction can be described within the range of the theory of volumetric-viscous flow of the porous body. Quadratic dependence is established of compact niobium shift viscosity on time at temperatures of hot pressing. Energy values of viscous flow activation of compact niobium, that contain 31 kcal/mol, point to the plastic flow of the material at high pressing. (auth)

2902 BETA III TITANIUM FEATURES "COLD" FORMABILITY. Guernsey, John B.; Petersen, Vincent C.; Dulis, Edward J. (Crucible Materials Research Center, Pittsburgh). Metal Prog., 96: No.5, 121-2; 124(Nov. 1969).

Properties of the alloy are discussed along with processability, corrosion resistance, and structure. The alloy is especially useful in fabrication of hard-to-make aircraft parts. (J.R.D.)

2903 WHEEL-TYPE ELECTRODE FOR WELDING BERYLLIUM METAL. Estes, C. L. (to U. S. Atomic Energy Commission). U. S. Patent 3,478,189. Nov. 11, 1969.

A wheel-type electrode for spot welding beryllium metal is provided with a coating of beryllium-containing metal on the working face thereof to enhance the welding characteristics of the wheel and improve the properties of the weld. Electrode "sticking" and deposition of electrode material in the weldment are virtually eliminated by employing this coated electrode. (AEC)

2904 ELECTRON-BEAM WELDING AT THE OAK RIDGE Y-12 PLANT. Huber, R. A.; Turner, P. W. (Union Carbide Corp., Oak Ridge, Tenn.). Weld. J. (N.Y.), 48: 787-90; 795-9 (Oct. 1969).

Information on electron-beam welding accrued from experience since 1961 is presented. Disadvantages which have received little attention in the past are discussed. Applications illustrating the versatility of electron-beam welding are described. Typical welding parameters for several materials and thicknesses are presented along with data on some unweldable material. Welder maintenance, operator training and safety of personnel are dealt with briefly. It is hoped that the information supplied will be useful to those now engaged in electron-beam welding and particularly to those considering the addition of an electron-beam welding unit to their operations. (auth)

2905 THE DEVELOPMENT OF BRAZING FILLER METALS FOR HIGH TEMPERATURE SERVICE. Gilliland, R. G. (Univ. of Wisconsin, Milwaukee); Slaughter, G. M. Weld. J. (N.Y.), 48: 463-s-8(Oct. 1969).

In an effort to provide brazed joints that approach the high-temperature strength capabilities of the refractory metals, an extensive brazing filler metal development program was conducted. This study revealed that alloys from the ternary systems of Ta–V–Nb and Ta–V–Ti possess excellent wetting and flow on the refractory metals. Alloys from these systems, which possess flow points between 3000 and 3650°F, are ductile at room temperature and exhibit good elevated-temperature stability with only a minor tendency to interact with the base metal. Joints made with these filler metals possessed shear strengths from 18,000 to 30,000 psi, when testing in vacuum at 2000°F. Evaporation of vanadium and titanium during vacuum brazing apparently results in significant increases in remelt temperature; the change in melting temperature often exceeds 1100°F. (auth)

2906 ESTIMATING ALLOY DENSITIES. Hull, Frederick C. (Westinghouse Research Labs., Pittsburgh). Metal Progr., 96: No. 5, 139-40(Nov. 1969).

Data representing 235 superalloys and stainless steels were used in devising a formula for calculating densities on the basis of composition. The formula and its uses are discussed. (J.R.D.)

2907 INVESTIGATION OF THE KINETICS OF DENSIFICATION IN HOT PRESSING OF CORUNDUM AND ZIRCONIUM DIOXIDE. Alekseenko, L. S.; Degtyareva, E. V.; Kaynarskii, I. S. Fiz. Khim. Obrab. Mater., No. 3, 87-94(1968). (In Russian).

It can be assumed that in the first minute there takes place a reorientation and redistribution of the particles under the action of the applied pressure, and holding under pressure leads to a marked change in the density of zirconium dioxide. After intensive densification during the first minute, the process slows down sharply. However, the density of samples pressed at 2000°C is far greater than that of samples pressed at 1800°C; this difference in density increases with an increase in pressure holding time. Intensive densification of alumina also takes place during the first 5 minutes of holding under pressure (density 3.94 gr/cm^3, porosity 1.01%). Further increase in holding time increases density only slightly. It was concluded that densification in hot pressing of oxides cannot be described by a single mechanism, and takes place in three stages and include a stage of redistribution and slipping of the particles comparable to what takes place during semidry pressing at room temperature; an intermediate stage in which the densification mechanism can be explained by plastic flow; and a final stage in which densification takes place by volumetric diffusion. In hot pressing, the rate of shrinkage is inversely proportional to applied pressure. (ATD)

2908 NOW, A NON-CYANIDE CADMIUM. Prod. Finish. (Cincinnati), 33: 194; 196; 198; 200(June 1969).

A new chloride-based solution for deposition of Cd from a bath free of cyanide is offered with brighteners for decorative work and unbrightened for utilitarian plating. Two big advantages are the elimination of cyanide-contaminated rinse water and a reduced tendency for H embrittlement in plating high-strength steel. Tanks must be lined with polyvinyl chloride, rubber, polyethylene or fiber glass, and anodes must be of pure Cd slab, drilled and tapped for anode hooks, preferably of Ti. Heating coils of Teflon, or Teflon-coated Cu, graphite heat exchangers, or quartz immersion heaters are recommended. Characteristics of the bright Cd bath include 80 to 90% efficiency, ability to plate at relatively high cathode current densities, excellent bath stability, and good throwing and covering power. (Metals Abstr.)

2909 INFLUENCE OF PROTECTIVE ATMOSPHERE AND SUBSTRATE TEMPERATURE ON THE PROPERTIES OF MOLYBDENUM COATINGS APPLIED TO GRAPHITE. Elyutin, E. P.; Kostikov, V. I.; Shesterin, Yu. A. Svar. Proizv., No. 6, 39-40 (June 1969). (In Russian).

A special metallizing chamber was built to house a plasma head for applying Mo to a graphite specimen. The chamber was evacuated to a pressure of 10^{-1} torr and then filled with Ar. This operation was carried out twice. The substrate was heated electrically and the temperature measured with a W/Re thermocouple. The deposited material came from a Mo wire. All specimens were polished by methods similar to those for metallographic specimens to eliminate effects of surface roughness on the bond between the coating and base. The temperature of the substrate varied from 20 to 1500°C. Experiments were also carried out in air with unheated specimens. Bond quality was determined by a shearing method. Metallization in air with unheated specimens gave a bond strength of 5.8 kg/cm^2. The O content of the coatings apparently had a considerable effect on the bond strength. No bond occurred in a protective atmosphere under the same conditions as the air-metallized specimens. It was established that atomizing in an inert atmosphere reduced the gas content in the coating, and the coating hardness decreased. The bond strength of the Mo coating with the graphite increases as the substrate temperature is increased to 1200°C. (Metals Abstr.)

2910 USES OF ELECTRODEPOSITED ZINC AND CADMIUM COATINGS. Brussig, P. Technik (Berlin), 23: 38-40(Jan. 1968). (In German).

Zinc and Cd are anodic with respect to iron and steel and thereby can provide corrosion protection for these metals. Compared with Zn, Cd has a higher chemical stability, is more toxic, and is more expensive. The corrosion resistance of both Zn and Cd is improved by chromate plating. Chromate plated Zn coatings are used in natural, marine, and warm moist environments. Non-chromate plated Zn coatings are used for mains and drinking-water installations, and for household utensils. Chromate plated Cd coatings are used for brass parts liable to stress corrosion. Non-chromate plated Cd coatings are used in chemical plants, for plumbing installations, and in electrical equipment. These coatings are also used as a barrier material between metals with relatively large electrochemical potential differences, and between metals and wood or plastics. (Metals Abstr.)

2911 TUNGSTEN CARBIDE COATING APPLIED BY DETONATION GUN PROCESS SOLVES MAJOR WEAR PROBLEM FOR IBM. Ind. Heat., 36: 840; 844(May 1969).

Coatings of tungsten carbide are applied to the hold-type electromagnets of a printer by a detonation gun process. An oxyacetylene gas mix is pressure fed into the gun along with powdered coating material. The mixture is then ignited and propelled to the workpiece at a speed of 2500 fps. Coating thickness ranges from 0.003 to 0.010 in. (Metals Abstr.)

Properties Evaluations

Refer also to abstracts 2169, 2341, 2348, 2401, 2407, 3054, 3463, and 3468.

2912 (AWRE-O-56/69) SURFACE SPRAY FROM EXPLOSIVELY ACCELERATED METAL PLATES AS AN INDICATOR OF MELTING. Bristow, W. F.; Hyde, E. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Sept. 1969. 31p. Dep. CFSTI (U. S. Sales Only). UK 9s. 0d.

The various forms of spray emanating from the surface of explosively accelerated metal plates are described and possible sources suggested. It is concluded that the occurrence of some of the visible features depends on the metal being molten and that it is therefore possible to obtain evidence of the state of the metal from high speed dynamic photographs. (UK)

2913 (BARC-358) STUDIES ON ELECTRICAL CONDUCTIVITY OF UO_2. Rao, S. V. K.; Agnihotri, P. K.; Moorthy, V. K. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 19p. Dep. CFSTI (U. S. Sales Only).

It was considered that the changes in the electrical conductivity of UO_2 pellets would be related to sintering. Electrical conductivity of sintered urania pellets was measured at room temperature. Powders of different crystallinity were prepared by calcination of ammonium diuranate (ADU) at 600 to 1500°C and the samples were sintered at temperatures between 600 to 1500°C. An attempt was made to explain the changes in conductivity on the basis of crystalline development in the powders, densification of the compacts, and grain-growth during sintering. (auth)

2914 (BMI-1873) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE. PHASE II. Task 17. Progress Report, May-September 1969. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1969. Contract W-7405-eng-92. 7p. Dep. CFSTI.

Ductile pipe rupture studies were continued. The initial phase experimental data provided a basis for assessing the size of defects required to produce failure in piping systems of either pressurized-water or boiling-water reactors. The current studies were concerned with determining the effects of pressure, mechanical stress, tube geometry, and flaw orientation on the initiation and arrest of crack propagation in stainless and carbon steel pipe, and with determining the range of area-opening-versus-time rates generated in the pipe failure experiments. (L.C.L.)

2915 (ORNL-4470, pp 5-6) DEFORMATION AND ANNEALING OF METALS. Vandermeer, R. A. (Oak Ridge National Lab., Tenn.).

The unique surface texture and the zone at intermediate depths lacking certain of the strong orientations usually present in body-centered cubic metals appear to be associated with high frictional forces and fabricating under high body rolling conditions respectively. Despite differences in dislocation substructure and other deformation characteristics, the cold-rolled center texture of an Nb-40% V alloy was identical to that of pure niobium. Isothermal recrystallization of moderately deformed aluminum was studied by quantitative metallography and found consistent with a proposed edge-nucleated, growth-controlled model. The kinetics of recovery of x-ray line broadening in niobium and Nb-40% V are being analyzed in terms of dislocation behavior. (auth)

2916 (ORNL-4470, pp 43-4) SUPERCONDUCTING MATERIALS. Love, G. R.; Koch, C. C. (Oak Ridge National Lab., Tenn.).

The effect of the magnetic nature of a precipitate particle on its ability to pin superconducting fluxoids was investigated by dispersing yttrium and dysprosium metals in niobium and testing the com-

posites at low temperatures. Both additions drastically increased the superconducting critical current density and magnetic hysteresis of the niobium at all fields and temperatures in the superconducting state but did not change the limiting fields and temperatures for the occurrence of superconductivity. The ability of a planar defect to pin fluxoids was investigated by examining the grain size dependence of the critical current density in Nb–33% Zr. When the effective grain or cell size was varied from 0.25 μ to 1.5 mm, the apparent critical current density, at constant applied field and temperature, decreased by more than two orders of magnitude. (auth)

2917 (ORNL–4470, pp 45–9) SURFACE REACTIONS OF METALS. Cathcart, J. V. (Oak Ridge National Lab., Tenn.).

Interest in the role of stress in the oxidation of metals and alloys has continued. Research efforts have been divided between studies of stress effects in the oxidation of refractory metals and in a uranium-base alloy, diffusion measurements in tungsten, and a further refinement of our method for deducing strain and thickness for thin oxide films from x-ray line shapes. Oxidation rate measurements for tantalum confirmed rate reversal with increasing temperature between 650 and 800°C. A flexure technique is being used in investigating the role of stress in this phenomenon. The effect of stress was also evident in the surface morphology of the oxide formed on U–7.5% Nb–2.5% Zr. Oxidation rate measurements between 160 and 275°C are reported as well as the results of a hot-stage-microscope study of the oxidation of the alloy at 800°C. Diffusion data for Nb, Ta, and W in tungsten were obtained from about 1300 to 2500°C. The importance of short-circuit diffusion modes was emphasized in this work. A reassessment of the methods of x-ray line shape analysis for thin oxide films showed that the experimental data suffered from a "hook effect," which has led to errors in thickness estimates by this technique. Corrections for this error have been developed. (auth)

2918 (ORNL–4470, pp 58–62) PHYSICAL AND MECHANICAL METALLURGY OF REFRACTORY ALLOYS. Inouye, H. (Oak Ridge National Lab., Tenn.).

Details of the interactions of refractory metals with active gases in vacuum between 600 and 1200°C were reviewed; the extent and kinetics are governed by the deviation of the interstitial concentrations from equilibrium. The solubility, diffusivity, and permeability of nitrogen in tungsten were determined and compared with published data and with other metals. The permeability of nitrogen through tungsten is several orders of magnitude lower than through other refractory metals. The precipitation kinetics of Nb–Hf alloys within the miscibility gap are controlled by excess vacancies. Modulated structures have not been observed. The creep-rupture properties to 1000 hr of Nb-, Ta-, and Mo-base alloys are sensitive to the pretest annealing temperatures. The data are being correlated with the microstructures. Brazing alloys based on Ti–Zr–Ge and Ti–V–Cr are suitable for joining refractory metals, ceramics, and graphite to themselves and to each other. About 80 gas tungsten-arc welds were used to construct a complex T-111 forced-circulation loop. Three field welds were made in a portable inert-atmosphere welding device. Theoretically based analyses of the effects of temperature and alloying on the electronic and lattice components of thermal conductivity of metals were used to extrapolate accurate low-temperature data to 1700°K. Calculated values of the thermal conductivity of tungsten alloys at high temperature were within 10% of measured values where available. (auth)

2919 (ORNL–4470, pp 63–7) TUNGSTEN METALLURGY. Schaffhauser, A. C.; Patriarca, P. (Oak Ridge National Lab., Tenn.).

The effects of prior metallurgical structure and extrusion temperature between 1150 and 1700°C on the structure of duplex tube-shell extrusions of powder-metallurgy tungsten at an extrusion ratio of 3 were determined. With the extrusion conditions investigated, a wrought duplex structure was obtained only by extruding a recrystallized starting structure at 1150°C. Large quantities of high-purity chemically vapor-deposited (CVD) tungsten sheet were produced for mechanical property measurement, but deposition of large sheets of W–5% Re was handicapped by nodule formation and gradients in deposit thickness and rhenium composition. Uniform rhenium alloying was obtained by maintaining the deposition temperature above 700°C. Uniform deposit thicknesses were obtained by raising the deposition pressure from 10 to 50 torr, but this also reduced the rhenium deposition efficiency. Periodic reversal of the gas flow to minimize gas phase depletion resulted in a layered structure with fine interlayer porosity. Fully dense deposits of vanadium were obtained by the hydrogen reduction at 1000 to 1200°C of three different feed materials – VCl_3 powder entrained with argon, VCl_4 gas chlorinated in situ, and VF_5 gas. Bend tests of CVD W–5% Re sheet showed a minimum in the ductile-to-brittle transition temperature of 150°C after annealing 1 hr at 2200°C. Lower annealing temperatures were not sufficient to sinter fine grown-in porosity in the as-deposited material. Gas bubble formation in annealed CVD materials was correlated with the fraction of the absolute melting point (T_m) in which the material was deposited. In materials deposited below about $0.3T_m$ a large supersaturation of vacancies can be produced during deposition and their coalescence with gaseous impurities during annealing results in the nucleation and growth of gas bubbles. Intergranular hot cracking of fusion welds in several grades of tungsten was examined by electron fractography. From these observations a mechanism of hot cracking was proposed based on the growth and coalescence of pores into grain boundary cracks by the stress-induced diffusion of vacancies. In a comparison of the creep-rupture properties of arc-melted (AM) and powder-metallurgy (PM) W–25% Re at 1650 and 2200°C, the PM material exhibited shorter rupture lives and much lower ductilities than the AM material. Based on 1000-hr stress-rupture data for arc-melted tungsten alloys between 1650 and 2200°C the W–5% alloy is the strongest, followed by unalloyed W, W–26% Re, and W–25% Re–30% Mo. (auth)

2920 (ORNL–4470, pp 160–2) HEAVY SECTION STEEL TECHNOLOGY. Canonico, D. A. (Oak Ridge National Lab., Tenn.).

The Metals and Ceramics Division is actively involved in the Heavy Section Steel Technology (HSST) Program as consultants and experimentalists. Studies on heavy section steel submerged-arc weldments showed that the failure toughness of the weld metal is superior to that of the quenched and tempered 12-in.-thick Mn–Mo–Ni steel base plate. A coordinated effort between this Division and the Inspection Engineering Department showed that entrapped slag is responsible for the indications nondestructively disclosed in HSST plate 01. (auth)

2921 (ORNL–4470, pp 168–80) LMFBR CLADDING AND STRUCTURAL MATERIALS. Adamson, G. M. Jr.; Weir, J. R. Jr.; Harms, W. O. (Oak Ridge National Lab., Tenn.).

Work directed at both short- and long-term LMFBR applications in cladding fabrication, effects of irradiation on cladding and structural alloys, and welding for vessels and components is summarized. As the result of studies on the effect of drawing and interpass annealing schedules, small-diameter tubing of type 316 stainless steel was produced with an ASTM grain size of 12 that otherwise met the specifications for FFTF fuel cladding. Tubes fabricated from titanium-modified type 304L stainless steel by a schedule involving 10 to 15% reduction per pass exhibited less preferred orientation than those undergoing 20 to 30% reduction per pass; the differences in texture between drawn and planetary-swaged tubing also were established. The morphology of ϵ- and α'-phases produced during cold working of titanium-modified type 304L stainless steel was determined. Boron contents greater than 10 ppM were detrimental to the hot ductility of type 316 stainless steel. Ultrasonic and dye-penetrant techniques were developed for nondestructive evaluation of LMFBR fuel cladding. The ductility of titanium-modified type 304L stainless steel tubing in biaxial creep-rupture tests was comparable to that of commercially available unmodified alloy. The elevated-temperature mechanical properties of type 316 stainless steel were determined after irradiations at 550, 650, and 750°C to a thermal fluence of 9×10^{20} neutrons/cm^2. The short-time tensile ductility at 550 to 750°C was lowered in all cases and varied inversely with the test temperature. Increases in yield strength after irradiation at 650 and 750°C resulted from thermal aging and not from the effects of irradiation. At 650°C the creep rate increased and the ductility and rupture life decreased with increasing irradiation temperature. The increase in creep rate was the result of thermal aging and not of irradiation. The effect of irradiation temperature in the range of 370 to 525°C and fast neutron fluence (>0.1 MeV) to 9×10^{22} neutrons/cm^2 on the microstructure as revealed by electron microscopy was investigated for types 304 and 304L stainless steels. Irradiation-induced voids approached a limiting size, which increased with irradiation temperature. Specimens of titanium-modified type 304L stainless steel containing 20 ppM of cyclotron-injected helium exhibited significantly higher ductility than comparable helium-injected specimens of standard type 304L stainless steel. An analytical study showed that while ion bombardment in cyclotrons cannot precisely simulate neutron-induced damage, it may serve as a useful supplement to neutron damage studies. Additions of 0.1% Ti increased the creep ductility of Incoloy 800 at 700 and 760°C; this effect was apparently independent of carbon content in the range 0.03 to 0.12%. Unalloyed vanadium irradiated at approximately 600°C to a maximum total neutron fluence of 1.7×10^{22} neutrons/cm^2 in the EBR-II contained 5×10^{15} voids/cm^3 with an average diameter of 120 A. No voids were observed in V–20% Ti irradiated under comparable conditions. The effects of welding

processes and conditions on the properties of thick-plate weldments in type 304 stainless steel were determined. (auth)

2922 (ORNL-4470, pp 181) MILITARY REACTOR FUEL ELEMENT PROCUREMENT ASSISTANCE. Beaver, R. J. (Oak Ridge National Lab., Tenn.).

During this year, assistance in standardization of specifications, review of technical requirements, and participation in fuel procurement and quality control audits was associated with the Type 4 core for the Navy's PM Reactor in Antarctica, two half-cores for the Army's MH1A Reactor, and 116 ETR-type fuel assemblies for the Air Force reactor at Wright-Patterson Field (AFNETR). Accomplishments include expediting prompt delivery of a PM core but rejection of defective control assemblies, improvement of MH1A specifications, and cost reduction for AFNETR fuel. (auth)

2923 (ORNL-4470, pp 212) ARMY PULSED RADIATION FACILITY REACTOR ASSISTANCE. Litman, A. P. (Oak Ridge National Lab., Tenn.).

In seeking an improved core alloy over U–10% Mo for pulse reactor service, the toughness of several uranium–molybdenum alloys containing small alloying additions was determined. After aging at the maximum embrittlement temperature of 475°C, at least one alloy showed a clear superiority in notch toughness at all aging times to 64 hr. (auth)

2924 ELECTROCHEMICAL INVESTIGATION OF OXYGEN DIFFUSION IN SOLID AND LIQUID METAL. Rickert, H.; El Miligy, A. A. (Univ., Karlsruhe, Ger.). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 17-28(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

A description is presented of an electrochemical method in which it is shown how to apply to potentiostatic technique in conjunction with the galvanostatic technique. Potentialities of the methods in measuring the diffusion coefficient of oxygen in liquid Ag and liquid Cu are discussed. (J.R.D.)

2925 AN INVESTIGATION ON THE Ta–H SYSTEM BY INTERNAL FRICTION MEASUREMENTS. Cannelli, G.; Mazzolai, F. M. (Corbino Instituto di Acustica, Rome). Nuovo Cim., 64B: 171-80(Nov. 11, 1969).

The internal friction has been measured as a function of temperature in a series of tantalum–hydrogen alloys with atomic ratios varying from H/Ta ≤ 0.005 to 0.17. The temperature of the measurements covers the range 78 to 450°K; the vibration frequencies are included between 1.5×10^2 and 1.0×10^5 Hz. Two anelastic relaxation peaks P_1 and P_2 have been observed near 100°K and in the range 180 to 300°K, respectively. The behavior of these peaks has been studied in connection with the phase compositions of the Ta–H system. The second relaxation effect P_2 was found to be a suitable tool for investigating the phase diagram of the system; its activation energy is 0.38 ± 0.05 eV and its limiting relaxation time 2×10^{-14} s. (auth)

2926 THERMAL RESISTANCE OF MOLYBDENUM DISPERSIONS CONTAINING OXIDES OF ZIRCONIUM, TITANIUM, HAFNIUM, VANADIUM, YTTRIUM, AND LANTHANUM. Kravtchenko, T. G.; Zhuk, N. P.; Gurbenko, T. S.; Dzeneladze, Zh. I.; Gol'tsev, V. P.; Khodkin, V. I.; Semina, L. V. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., No. 6, 110-15(1968). (In Russian).

The thermal resistance of Mo alloyed with MgO and Al_2O_3 was studied in air at 1000°C. Alloys with MgO possessed higher thermal resistance than alloys with Al_2O_3. However, the thermal resistance increase with the additions of MgO and Al_2O_3 was negligible (1.1 and 1.2 times higher with 1% addition of oxides). Additions of ZrO_2, TiO_2, HfO_2, V_2O_5, Y_2O_3, and La_2O_3 into Mo within the error of experiment did not affect the thermal resistance of the alloy. At 550°C in air, the thermal resistance of all the alloys examined was lower than the thermal resistance of non-alloyed molybdenum. (R.V.J.)

2927 INFLUENCE OF COLD WORK AND HEAT TREATMENT ON THE CREEP RUPTURE AND CREEP BEHAVIOR OF VANADIUM ALLOYS. Boehm, Horst; Schirra, Manfred (Kernforschungszentrum, Karlsruhe, Ger.). Z. Metallk., 60: 879-85 (Nov. 1969). (In German).

Two vanadium alloys were used to investigate the influence of cold work (28 to 80% strain) and annealing (at 700 to 1100°C) subsequent to cold working on the creep rupture and creep behavior at 650°C. The cold work increased the creep rate with increasing degree of work and decreased the time to rupture while increasing the elongation at fracture considerably. Concurrently, the stress exponent n in the relation $\dot{\epsilon} = k \cdot \sigma^n$ was decreased by cold work. Annealing of cold worked specimens prior to the creep test led to an increase of the time to rupture and a decrease of creep rate with increasing annealing temperature. Since recovery of cold worked vanadium alloys was complete after a few hours at 650°C, the influence of cold work after rather long times must be due to differences in the recovered microstructure. The results are discussed in terms of this aspect. (auth)

2928 DIFFUSION AND PERMEATION OF DEUTERIUM IN PALLADIUM–SILVER AT HIGH TEMPERATURE AND PRESSURE. Hickman, R. G. (Univ. of California, Livermore). J. Less-Common Metals, 19: 369-83(Dec. 1969).

The solubility, diffusion coefficient, and permeability of Pd-25 Ag alloy to deuterium have been measured between 0 and 1000 psi at 300, 400, and 500°C. Substantial deviations from ideal behavior are observed, particularly for diffusion coefficients, so that permeability cannot be represented as a simple function of pressure. After the diffusion coefficients are corrected for chemical nonideality, an additional increase by a factor of two remains in the concentration dependence of diffusivity. This is attributed to the expanded lattice of the alloy when the deuterium-to-metal ratio is high. A strain-induced shift in solubility was also observed. (auth)

2929 DENSITY OF ZIRCONIUM SYSTEMS DURING SINTERING. Karklit, A. K.; Alekseeva, A. N. Ogneupory, No. 5, 35-8(May 1969). (In Russian).

The behavior of zirconium systems containing 63.47 and 65.74 percent zirconium dioxides at 1550 to 1650°C was studied. With an increase of temperature during sintering, an increased degree of decomposition of zircon was observed. The dependence on temperature was increased with increased impurity content. (tr-auth)

2930 MODERATOR AND CONTROL MATERIALS. Reactor Mater., 12: 236-47(Winter 1969-70).

Research efforts are summarized on graphite, Be, Be alloys, solid metallic hydrides, metallic control materials; and nonmetallic poisons. (J.R.D.)

2931 HIGH-STRENGTH MARTENSITICALLY AGING (MARAGEABLE) ALLOYS. Perkas, M. D. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 58, 122-32(1968). (In Russian).

Experiments with binary Fe–Ni alloys were carried out to elucidate the effects of prior phase hardening of austenite on increase in the strength of the martensite resulting from the subsequent $\gamma \rightarrow \alpha$ transformation. It turned out that following such treatment the strength of martensite increased by only 10 to 15 kg/mm^2. Further investigation revealed that a marked hardening can be attained by aging the martensite of carbon-free Fe–Ni (11 to 12% Ni) alloys treated with Ti, Al, Mn, Nb, Zr, and Mo. These elements variously affect the degree of hardening during maraging. Such a hardening is the greatest in the Ti-treated alloy (ΔH_V = 240 units) (particularly following maraging of the alloy with 2.35% Ti for 1 hr at 500°C) and the smallest in the Mo-treated alloy (ΔH_V = 90). The presence of Ni in the alloy is a prerequisite for the maraging to occur. In alloys of this kind maraging can result in a strength of the order of 210 to 230 kg/mm^2 without any marked detriment to plasticity and without requiring pressure working of the material. Heat treatment resulted in the formation of martensite and its subsequent aging at 480 to 500°C. An important advantage of the alloys is that the original martensite displays high plasticity indicators and a low hardening coefficient, which allows considerable plastic deformation of the alloy, even at room temperature, prior to its aging. Moreover, alloys of this kind are readily machined and welded and they can be readily processed into complex-shaped products. Alloys in the high-strength state are characterized by a low temperature of transition to brittle state and low susceptibility to crack propagation. The high plasticity and low cold brittleness threshold of the nonaged martensite of Fe–Ni base alloys were chiefly due to the presence of Ni which reduced the extent to which the dislocations were held fast by impurities and weakened the resistance of the crystal lattice of Fe to the migration of dislocations. Aging resulted in disperse new-phase particles that were uniformly distributed in the interior of martensite crystals. (ATD)

2932 DEFORMABILITY OF CERTAIN REFRACTORY METALS. Izotov, V. M.; Krupin, A. V.; Pavlov, I. M. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Chern. Met., No. 7, 54-6(1968). (In Russian).

The investigation deals with the deformability of vanadium, tantalum, and niobium during their rolling as a function of the method of their melting (electron beam melting and arc melting). Deformability was determined by the method of rolling wedge-shaped and rectangular specimens as well as by means of upsetting with a drop hammer until the formation of the first crack. Microstructural examination indicated that despite the high purity of these metals when melted by the electron-beam method their macrocrystalline,

columnar structure is unfavorable to pressure working. Cold working such as cold rolling resulted in structural inhomogeneity and increase in deformation resistance which cannot be eliminated by any subsequent method of pressure-working or heat treatment. As for the hot working of refractory metals, it improved processability and reduced deformation resistance, and involved intense absorption of active gases by these metals resulting in surface cracking and contamination of the surface layer which must subsequently be removed. These findings as well as analysis of plasticity diagrams (in which plasticity was estimated according to relative deformation corresponding to the occurrence of the first few cracks) indicated that the deformation of ingots of electron-beam melted vanadium should be performed at relatively high temperatures provided that protective shells or coatings are used to prevent the oxidation and gas absorption of these metals. The plasticity of V nearly doubled with increase in temperature, amounting to 40% at 400°C and 75% at 1200°C, while the plasticity of electron-beam melted Nb and Ta varied insignificantly within the 600 to 1200°C range. In view of the increase in oxidation and gas absorption with rise in temperature, it may be assumed that the pressure-working of Nb and Ta should be performed at the minimum permissible temperatures. As for arc-melted Nb, Ta, and V, the findings on the experimental forging of these metals indicated that, despite their relatively favorable structure, their high content of interstitial impurities also made them unamenable to cold working, while their hot working also entailed the danger of intense oxidation and gas absorption. The use of protective shells and coatings to prevent oxidation and gas absorption in refractory metals at high temperatures is not the best method; a more effective method appears to be the new method of hot plastic deformation (forging, rolling, etc.) in vacuo or in inert atmospheres. (ATD)

2933 BRITTLE FRACTURE IN MOLYBDENUM. Shaw, Bevil J. (Westinghouse Research Labs., Pittsburgh). Scr. Met., 3: 815-20(Nov. 1969).

Experimental data are used in an evaluation of metal cracking and twinning theories which suggest that slip-dislocation movement is a necessary prerequisite to their initiation. The experiments were conducted using Mo specimens. (J.R.D.)

2934 DIFFUSION OF Zr IN Ag. Pravoverov, N. L.; Kolonin, Yu. G. Izv. Akad. Nauk SSSR, Metal.; No. 2, 188-90 (Mar-Apr 1969). (In Russian).

Physicochemical methods were used to study the solubility of Zr in solid Ag. The results showed that an increase in temperature up to 900°C increased the solubility from 0.04 ± 0.05 to 0.1 ± 0.13 wt %. (tr-auth)

2935 INCREASE OF PLASTICITY OF CAST AND RECRYSTALLIZED Mo ALLOYS DURING SEPARATION OF THE HIGH-TEMPERATURE SECOND PHASE. Movchan, B. A.; Statkevich, V. N. Izv. Akad. Nauk SSSR, Metal.; No. 2, 129-36(Mar-Apr 1969). (In Russian).

Studies were made on the intercrystalline breakdown of cast Mo containing C and B. Increased plasticity in cast and recrystallized Mo was achieved by additions of C and B resulting in high temperature heterogenization (separation of primary carbides or borides). The dependence of the plastic properties on the B and C contents revealed high maxima at 0.05 to 0.08% C and 0.2% B. Transcrystalline breakdown was observed in the vicinity of maximum plasticity. (tr-auth)

2936 THE EFFECT OF A PROTECTIVE ATMOSPHERE AND THE PACKING TEMPERATURE ON THE PROPERTIES OF MOLYBDENUM COATINGS APPLIED TO GRAPHITE. Elyutin, V. P.; Kostikov, V. I.; Shesterin, Yu. A. Svar. Proizv., No. 6, 39-40(June 1969). (In Russian).

A chamber was manufactured to study the effects of the deposition atmosphere on the properties of molybdenum coatings. The experimental device permitted application of the coating on flat samples moving relative to a plasma head without additional heating of the samples or application of the coating to stationary samples with heating in an atmosphere of inert gases. It was established that during deposition in an inert atmosphere the gas content in the coating is reduced, and the hardness of the coating is also lowered. On raising the temperature of the substrate to 1,200°C the adhesive strength of the molybdenum coating with the graphite increases. Data are tabulated for the microhardness of the coating during deposition and the x-ray phase analysis during deposition in the air and in a chamber with a neutral atmosphere as functions of temperature. (JPRS)

2937 PREDICTION OF FAILURE TIMES FOR DECAY-HEATED CAPSULES CONTAINING ALPHA-EMITTING ISOTOPES. Stephenson, R. L.; Swindeman, R. W. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol., 7: 572-5(Dec. 1969).

An analytical model has been developed for use of conventional creep data, taken at constant temperature and load, to predict failure times under conditions of varying stress and temperature according to monotonic functions of time. The validity of this method was examined experimentally for T-111 (Ta-8% W-2% Hf); the experimental data are in good agreement with the predictions. (auth)

2938 EFFECT OF ADDITION OF CHROMIUM, MOLYBDENUM, OR TUNGSTEN ON THE ELINVAR PROPERTY OF NICKEL AT HIGH TEMPERATURE. Masumoto, Hakaru; Sawaya, Shohachi; Nakamura, Naoji (Research Inst. of Electric and Magnetic Alloys, Sendai). Nippon Kinzoku Gakkaishi, 33: 1003-6(Sept. 1969). (In Japanese).

Measurements of the linear coefficient of thermal expansion, Young's modulus and its temperature coefficient, and density were carried out to determine the effects of Cr, Mo, or W additions on the anomaly of Young's modulus, i.e., the Elinvar property of nickel at high temperature. It was found that in the Ni-Cr, Ni-Mo and Ni-W binary systems the Elinvar property of nickel at high temperature falls gradually to room temperature along the magnetic transformation point with increasing addition of each element, and also a minimum linear coefficient of thermal expansion, characteristic of the Invar property, appears in a composition range where the Elinvar property is revealed. (auth)

Structure and Phase Studies

Refer also to abstracts 2933 and 3277.

2939 (LA-tr-69-25(Draft)) INFLUENCE OF SMALL ADDITIONS OF ALLOYING ELEMENTS. Colombie, Michel; Decours, Jacques; Foure, Michel; Magnier, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Los Alamos Scientific Lab., N. Mex., from report CEA-R-3529. 24p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 3070.

2940 (ORNL-4470, pp 7-11) DEFORMATION OF CRYSTALLINE SOLIDS. Williams, R. O. (Oak Ridge National Lab., Tenn.).

Work concerning the nature of slip and twinning in rhenium single crystals, precipitation in refractory alloys of the hafnium-niobium type, the changes in structure during deformation of nonrandom alloys, and the characterization of dislocations and zonal twin dislocations in anisotropic crystals is summarized. (auth)

2941 (ORNL-4470, pp 14-17) ELECTRON MICROSCOPY. Stiegler, J. O. (Oak Ridge National Lab., Tenn.).

Changes in microstructure of highly irradiated aluminum and aluminum alloys are described. In addition to voids and dislocation loops resulting from displacement processes, gas bubbles and a solid precipitate believed to contain transmutation-produced silicon were observed. Complementary studies of quenching defects in aluminum are summarized. Precipitation phenomena in Hastelloy N are reported, and observations on the recrystallization behavior of nickel 270 and the formation of gas bubbles in electrodeposited nickel are presented. Measurements of the stored energy induced in aluminum single crystals and gold-silver alloy polycrystals by room temperature tensile deformation are described. (auth)

2942 (ORNL-4470, pp 23-7) MOESSBAUER STUDIES OF ALLOYS. Borie, B. S. (Oak Ridge National Lab., Tenn.).

Mössbauer spectra taken at 4°K with ^{61}Ni in ionic compounds containing Ni^{2+} and Ni^{4+} ions led, after subtraction of second-order Doppler shift, to an approximate value for the difference of the nuclear radius of ^{61}Ni in the first excited state and the ground state. With this result, the measured isomer shifts in copper-nickel alloys could be interpreted in terms of changes of the electronic configuration of nickel upon alloying: nickel as impurity in copper has at most 5% of a 4s electron less or 25% of a 3d electron more than in pure nickel, in contradiction to predictions of a rigid-band model. The results of Mössbauer experiments with ^{57}Fe following neutron capture in bcc iron-aluminum alloys were interpreted in terms of a collision model, by which the fraction of ^{57}Fe recoil atoms that come to rest at a lattice site, the number of point defects, and the distribution of iron and aluminum atoms in the immediate neighborhood of their final positions were estimated. Preliminary estimates of the influence of point defects on hyperfine fields were deduced from the experimental data in conjunction with the model results. (auth)

2943 (ORNL-4470, pp 30-3) PHYSICAL PROPERTIES. McElroy, D. L. (Oak Ridge National Lab., Tenn.).

Accurate measurement and theoretically based analyses of related physical properties of solids provided guidelines for understanding of their electronic and lattice heat transport. A diversity of solids is under study. Electrical resistivity measurements on tantalum were completed to 2600°K to provide data for thermal conductivity extrapolations. The Lorenz function of gold was shown to be similar to that of copper from 80 to 400°K. Thermal conductivity studies on ThO_2 and UO_2 showed their Debye temperatures to be nearly equal. Measurements on LiF revealed a strong radiation component that supplements lattice conduction above 450°K. Calorimetric studies on nickel and iron revealed specific heat capacity discontinuities at their Curie temperatures. Studies are in progress on UN and ThN. (auth)

2944 (ORNL-4470, pp 50-1) THEORETICAL RESEARCH. Borie, B. S. (Oak Ridge National Lab., Tenn.).

Previously developed band theory programs were used to investigate the thermopower of copper and the Knight shifts of copper and some of its alloys. A recently developed technique for investigating the electronic states in disordered systems was tied in with a method that was developed earlier, and the experience already gained with the older method has been used to elucidate the newer. The motion of protons in molecules has been investigated, showing that the protons are more delocalized in such systems than has usually been assumed. (auth)

2945 (ORNL-4470, pp 52-7) X-RAY DIFFRACTION. Yakel, H. L. (Oak Ridge National Lab., Tenn.).

Routine diffraction work during the reporting period is summarized. Crystal structures of $RbBrO_4$ and two forms of $Ti(AlCl_4)_2$ were studied. A computer program for plotting stereographic projections of lattice plane normals and directions was prepared. Metastable phases formed on quenching and aging a gamma-stabilized uranium alloy were shown to have structures based on systematic atom displacements rather than on chemical ordering as previously reported. Thermal diffuse x-ray scattering from samples of highly oriented graphite was analyzed to give a detailed model of the transverse and longitudinal vibration modes of the lattice. Good agreement is obtained with previous estimates of total rms displacements and with inelastic neutron scattering measurements. Small-angle x-ray scattering from aqueous solutions of salts of aliphatic quaternary ammonium halides demonstrated that polymolecular clusters of organic cations (or micelles) probably do not exist at the concentrations studied. Small-angle scattering from Ti-25 at. % Nb alloys, aged after beta quenching so as to form the metastable omega phase, has been analyzed to yield quantitative size and qualitative distribution parameters for the omega particles; this work has been complemented by high-angle diffraction studies of single crystals of the same alloy in several aged conditions. (auth)

2946 (UCRL-Trans-10385) PHYSICAL METALLURGY: SECTION OF THE TERNARY DIAGRAM U-O-N BY THE PLANE UO_2-U_2N_3. Blum, Pierre-L.; Laugier, Jean; Martin, Jean-Marie. Translated by Ralph L. McElroy for Univ. of California Lawrence Radiation Lab., Livermore, from Compt. Rend., Ser. C, 268: 148-51(1969). 5p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 20556.

2947 (WAPD-TM-833) CRITICAL ANGLE ULTRASONIC TECHNIQUE FOR DETECTING HYDRIDES IN ZIRCALOY. Willard, H. J. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1969. Contract AT(11-1)-Gen-14. 26p. Dep. CFSTI.

A feasibility study of a critical angle ultrasonic technique for detecting hydrides in Zircaloy was conducted. A focused ultrasonic beam incident on the surface of the specimen at the Rayleigh critical angle is used. The amplitude distribution of the reflected beam is very sensitive to the density and elastic properties of the specimen, both of which are altered by the presence of hydrides. Measurements were made at 1, 2.25, and 5 MHz in 0.140-inch-thick Zircaloy flat plate specimens of 0, 300, and 600 ppM nominal hydrogen content. For this work the sensitivity of the technique was 600 ppM and appeared to be limited by the surface preparation of the sample. (auth)

2948 CRYSTAL STRUCTURES OF INTERMETALLIC COMPOUNDS OF RARE-EARTH METALS AND 3d METALS. Kirchmayr, Hans Rudolf (Technische Hochschule, Vienna). Z. Metallk., 60: 778-84(Oct. 1969). (In German).

A systematic compilation and derivation of the types and crystal structures of the intermetallic compounds is given, which are stable in the binary and special ternary rare earth-metal-3d-metal systems. The influence of the crystal structures on the magnetic properties of intermetallic compounds is shown. (auth)

2949 CRYSTALLOGRAPHIC FEATURES OF TENSILE FRACTURE OF POLYCRYSTALLINE BERYLLIUM. Mackay, T. L.; Ingersoll, R. G. (McDonnell Douglas Corp., Newport Beach, Calif.). Metallography, 2: 137-48(Sept. 1969).

An etch pitting technique has been developed and has been combined with electron fractography to study the crystallographic features of tensile fracture of polycrystalline beryllium. The crack initiation and the plane of crack propagation of a fine-grain forged beryllium, as well as commercial sheet, were determined from room temperature to 800°F. The fracture origin was internal for both forged beryllium and commercial beryllium sheet. An intergranular origin was observed for forged beryllium at ambient and elevated temperatures, with crack propagation occurring by $\{11\bar{2}0\}$ fracture. Only transgranular cleavage was observed for commercial beryllium sheet, with crack initiation occurring by basal plane cleavage. (auth)

2950 ALPHA-PHASE NUCLEATION IN OMEGA-BEARING Ti-15V. Rhodes, C. G. (North American Rockwell Corp., Thousand Oaks, Calif.). Metallography, 2: 257-61(Sept. 1969).

A large number of studies have recently been made on the occurrence of metastable ω phase in several titanium binary alloys, but little work has been published on the precipitation of the equilibrium α phase from the $\beta + \omega$ structure. Additional evidence is presented for the nucleation of α phase at $\beta:\omega$ interfaces in a Ti-15 at.% V alloy. (auth)

2951 CRYSTALLOGRAPHIC SHEAR AND PLANAR FAULTS IN SOLIDS. Wadsley, A. D. (Commonwealth Scientific and Industrial Research Organization, Melbourne). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 1-15(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Models of reactions between solids or within a solid as they are affected by creation, diffusion, and interactions of defects are discussed. Theories are considered concerning defects in classes of solids including metals, ionic solids, covalent lattice compounds, and molecular crystals. The effects of various kinds of chemical bonds on defect behavior are discussed. (J.R.D.)

2952 DISLOCATION DAMPING AND INTERSTITIAL PINNING IN HIGH PURITY SINGLE CRYSTAL TANTALUM. Sanders, R. C.; Painter, S. R.; Turner, T. J. (Wake Forest Univ., Winston-Salem, N. C.). Scr. Met., 3: 855-8(Nov. 1969).

Application of the vibrating string model of dislocation damping to bcc metals is examined. The use of the loop length temperature dependence to obtain dislocation-solute binding energies in Ta is also examined. (J.R.D.)

2953 EFFECT OF GRAIN SIZE VARIATIONS ON THE LONG-TIME STABILITY OF ALLOY 718. Stroup, J. P.; Heacox, R. A. (Latrobe Steel Co., Pa.). J. Metals, 21: No. 11, 46-54(Nov. 1969).

Uniform, fine grain size is generally preferred in forgings of Alloy 718 for optimum properties. However, due to limitations imposed by forging equipment, forging size, and forging configuration, it is often impossible to produce this desired grain size; instead, some grain duplexing or grain coarsening occurs in certain areas throughout the forging. Stress-rupture tests were conducted before exposure, and after exposing specimens at 1250 and 50,000 psi or 1300°F, and 50,000 psi for 500 hrs on material having uniform fine grain size (ASTM 7 or finer), duplex grain size, and uniform coarse grain size (ASTM 5 or coarser). These grain sizes were obtained in forgings with a simple pansake configuration using varying forging techniques. The results of the rupture tests conducted before exposure showed an excellent correlation with grain size and Ni, Nb plate size. After exposure, rupture ductility increased and strength decreased owing to overaging. In duplexed samples the controlling factor appears to be the amount and size of the coarse grain. The optimum grain size for the best balance of rupture properties appears to be ASTM 6 to 7. (auth)

2954 THE EFFECT OF THERMOMECHANICAL HISTORY ON THE STABILITY OF ALLOY 718. Cremisio, R. S. (Special Metals Corp., New Hartford, N. Y.); Butler, H. M.; Radavich, J. F. J. Metals, 21: No. 11, 55-61(Nov. 1969).

Previous studies showed that Ni_3Nb precipitation behavior appears to follow a predictable pattern with increased strain in the precipitation range for this phase. Additional investigation was initiated in order to further the understanding of Ni_3Nb precipitation under similar strain conditions and to develop some information on the effects of such conditions on the stability of gamma prime and the formation of sigma or other phases often considered

detrimental to performance. Samples from a production heat were treated above the Ni_3Nb precipitation range and subsequently strained between 0% reduction of area (RA) and 35% RA at 1500°F Light and electron microscopy and x-ray diffraction studies were performed on samples in the as-strained condition; after a 1750°F gamma prime solution treatment; after a 1750°F treatment followed by a double aging, gamma prime precipitation treatment and after a fully aged plus 1250°F-500 hour exposure. It was found that the quantity of Ni_3Nb which precipitated during the 1750°F treatment step increases markedly with the degree of strain, that gamma prime stability is not significantly affected by strain or the quantity of Ni_3Nb precipitate, and that sigma and similar phases do not form during prolonged exposure at the upper end of the useful temperature range for this alloy, even at the highest strain level investigated. (auth)

2955 INTERSTITIAL ORDERING IN α-ZIRCONIUM–OXYGEN ALLOYS. Fehlmann, M.; Jostsons, A.; Napier, J. G. (Australian Atomic Energy Commission, Lucas Heights). Z. Kristallogr., 129: 318-42(Aug. 1969).

The structure of interstitial solid solutions in zirconium–oxygen alloys over the composition range 15.0 to 28.5 at.% O has been studied using x-ray, neutron and electron diffraction techniques. The superstructure observed in alloys of 25.0 to 28.5 at.% O corresponds to that observed by Holmberg and Dagerhamn. A different order arrangement which can be described in terms of a one-dimensional long-period superstructure occurs in alloys of 15.0 to 25.0 at.% O with a periodicity which increases with oxygen content. In alloys of 25.0 at.% O, both types of ordered arrangements occur, separately and coexisting, depending on heat treatment. (auth)

2956 ISOTHERMAL SECTION OF THE SYSTEM Ti–Zr–Cr. Kornilov, I. I.; Belousov, O. K.; Musaev, R. S. Izv. Akad. Nauk SSSR, Metal.; No. 2, 167-9(Mar-Apr 1969). (In Russian).

Isothermal cross sections of Ti–Zr–Cr were constructed at 1400, 1250, 1100, 800, 650, and 500°C in the range of a limited amount of Ti–Zr and cross sections passing through $TiCr_2$ and $ZrCr_2$ compounds. Two polymorphous modifications of metallic compounds δ and γ were observed in the ternary system. The existence of two ternary phases (liquid + β + γ) and (α + β + γ) was found in the isothermal cross sections at 1100 and 650°C, respectively. The appearance of the two ternary phase regions in the isothermal cross sections is the result of the presence of minimum (liquid → β) and (β → α) transformations in the Ti–Zr system. The Gibbs–Konovalov second rule may be applied to this type of transformations. (tr-auth)

2957 X-RAY STRUCTURAL ANALYSIS OF PHASE COMPOSITION OF ALLOYS OF Ce–Fe–Al, CONTAINING UP TO 33.3 AT. PERCENT Ce. Zarechnyuk, O. S.; Mys'kiv, M. G.; Ryabov, V. R. Izv. Akad. Nauk SSSR, Metal.; No. 2, 164-6(Mar-Apr 1969). (In Russian).

X-ray structural studies were made on the alloy Ce–Fe–Al containing from 0 to 33.3 at.% by weight Ce. An isothermal cross section was constructed at 500°C. Three ternary compounds, $CeFe_2Al_{10}$ (φ phase), $CeFe_2Al_7$ (ν_1 phase), and $CeFe_{1\text{ to }1.4}Al_{1\text{to }0.6}$ (ν_2 phase) were observed in addition to the known compound $CeFe_2Al_8$ (φ phase) in the Ce–Al–Fe system in the range of Ce concentration investigated. A solid solution of Al in a binary compound of Ce_2Fe_{17} with a maximum content of Al of 60 at.% was also observed. One ternary compound of the φ′ phase was the only one observed in equilibrium with Al-base solid solution. (tr-auth)

2958 PHASE TRANSITION IN VANADIUM. Finkel, V. A.; Glamazda, V. I.; Kovtun, G. P. Zk. Eksp. Teor. Fiz., 57: 1065-8(Oct. 1969). (In Russian).

The crystal structure of single-crystal vanadium is studied by low-temperature x-ray diffraction at temperatures between 77 and 300°K. A phase transition of the second kind occurs at 230°K. It entails a decrease of symmetry of the crystal lattice from a body-centered cubic to a tetragonal one. (auth)

2959 DIFFUSIONAL FLOW IN A HYDRIDED Mg–0.5 WT PCT Zr ALLOY. Karim, Anwar-ul; Holt, David L.; Backofen, Walter A. (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 245: 2421-4(Nov. 1969).

Specimens of a hydrided Mg–0.5 Zr alloy were strained in tension at 500°C and constant rates of 2×10^{-3}, 5×10^{-3}, and 2×10^{-2} min^{-1} Hydride-denuded zones formed at grain boundaries normal to the tensile-stress direction as a result of magnesium transport during diffusional flow. The width of the zones could be measured and the measurement used for calculating the diffusional component of the imposed tensile strain. The strain from diffusional flow was found to increase with imposed strain at a diminishing rate, tending to saturate at approximately 12%. Strain rate sensitivity of flow stress was low. The apparent non-Newtonian character of the diffusional flow is attributed to a non-Newtonian process acting in parallel with it which could be boundary shear. Fracture grows out of voids that form in the denuded zones. (auth)

2960 STRUCTURAL INVESTIGATION OF PRECIPITATION IN AN ALUMINUM ALLOY CONTAINING 1.1 WEIGHT PERCENT ZIRCONIUM. Izumi, Osamu; Oelschlaegel, Dietrich (Tohoku Univ., Sendai). Z. Metallk., 60: 845-51(Nov. 1969). (In German).

Structure and distribution of the precipitates in a highly supersaturated Al–1.1% Zr alloy were investigated at 200 to 550°C. In addition to the tetragonal equilibrium phase Al_3Zr, an intermediate phase with cubic ordered structure ($L1_2$-type) was found. At $T \geq 450$°C this phase occurred in the form of coherent spherical particles or, after redistribution of the spheres, as rods in fan shaped arrangement. At $T < 450$°C this phase was formed by discontinuous precipitation. Both the lattices of the intermediate and the equilibrium phase lay parallel to that of the matrix. The existence of the cubic ordered structure can be explained from the crystal structure of the tetragonal equilibrium phase. (auth)

2961 PRECIPITATION BEHAVIOR OF NICKEL–VANADIUM ALLOYS. Kramer, Karl-Heinz; Boehm, Horst (Kernforschungszentrum, Karlsruhe, Ger.). Z. Metallk., 60: 835-9(Nov. 1969). (In German).

Investigations of the precipitation behavior of nickel–vanadium alloys containing 15.4 to 16.5 wt % V have shown that only the tetragonal equilibrium phase Θ was precipitated. This was an ordered phase of $TiAl_3$ type structure which was coherent with the matrix during early stages of precipitation. Electron diffraction showed that the lattices of both the matrix and product phase was parallel. With increasing degree of decomposition the lattice strains in the c direction of the precipitate were increased while those in the a directions were decreased. The formation of (101) habit planes was interpreted to result from anisotropic strains. The activation energy of the precipitation process was about 50 kcal/mole as determined from hardness and resistivity measurements. The increases in yield stress due to precipitation can be satisfactorily rationalized with current theories of precipitation hardening. (auth)

2962 RARE-EARTH COPPER COMPOUNDS WITH $AuBe_5$ STRUCTURE. Buschow, K. H. J.; Van der Goot, A. S.; Birkhan, J. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals, 19: 433-6(Dec. 1969).

Rare-earth–copper compounds with a composition near 83.5 at.% Cu were investigated by x-ray diffraction. It is shown that the cubic $AuBe_5$ structure type occurs at an appreciably larger radius ratio than reported thus far in the literature. A structure determination is given for the compounds RCu_5 in which R represents one of the elements Tm, Er, Ho and Dy; these compounds crystallize in the cubic $AuBe_5$ type of structure. For the compounds with R = Gd, Tb, Dy and Y, in addition to the cubic $AuBe_5$ type, the hexagonal $CaCu_5$ type was observed. (auth)

2963 SYSTEM NIOBIUM–SULFUR. Kadijk, F.; Jellinek, F. (Rijksuniversiteit, Groningen, Netherlands). J. Less-Common Metals, 19: 421-30(Dec. 1969).

The following phases were found in the system niobium–sulfur: NbS_3, 2s-NbS_2, 3s-NbS_2, 2s-$Nb_{1+x}S_2$, 3s-$Nb_{1+x}S_2$, Nb_2S_3, h.t.-$Nb_{1-x}S$, l.t.-$Nb_{1-x}S$, $Nb_{21}S_8$. While NbS_3 is a diamagnetic semiconductor, the other niobium sulfides are metallic with nearly temperature-independent paramagnetism. H.t.-$Nb_{1-x}S$, stable above 780°C, has an orthorhombic structure of the MnP type with infinite zigzag Nb–Nb chains. The low-temperature form of $Nb_{1-x}S$ has a hexagonal superstructure of the NiAs type with triangular Nb_3 clusters. The structures of the other niobium sulfides that had been reported previously, were confirmed. (auth)

2964 AN ELECTRON MICROSCOPE INVESTIGATION OF THE FLUX PINNING CENTRES IN SUPERCONDUCTING V_3Ga TAPES. Nembach, E.; Tachikawa, K. (National Research Inst. for Metals, Tokyo). J. Less-Common Metals, 19: 359-67 (Dec. 1969).

The defect structure of V_3Ga tapes produced by a solid-state diffusion process, was studied by electron transmission using a microscope with an acceleration voltage of 500 kV. The only defects found in appreciable numbers were grain boundaries. It is concluded that these are the most important flux pinning centers. The amount of lossless current which could be carried by these tapes in the superconducting state was correlated with the grain size. (auth)

2965 PHASE EQUILIBRIA IN ZIRCONIUM-RICH ZIRCONIUM–CHROMIUM–OXYGEN ALLOYS. Rumball, W. M.; Elder, F. G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Less-Common Metals, 19: 345-58(Dec. 1969).

Phase equilibria in the system Zr–Cr–O have been studied by metallography, x-ray and electron diffraction, electron-probe microanalysis, hardness and thermal analysis in the composition ranges 0 to 2.25 wt % chromium and 0 to 2400 ppM oxygen. A binary (α-zirconium + $ZrCr_2$) eutectoid formed over a temperature range that expanded with oxygen concentration up to about 135°C for a 2400 ppM oxygen alloy. Oxygen also increased the chromium concentration of the eutectoid from between 0.7 and 0.95 wt % for a 0 ppM oxygen alloy and 1.25 wt % for a 2400 ppM oxygen alloy. The oxygen concentration of the α solid solution had a derived maximum of about 9000 ppM at approximately 900°C. The crystal structure determined for $ZrCr_2$ ($MgCu_2$ type, a = 7.021 Å) confirms earlier work. The impurity iron dissolved completely in $ZrCr_2$ but, up to 3 wt % iron, had no observable effect on the lattice parameter. Outstanding microstructural features were the formation of a twinned martensitic product in quenched 0.2 to 1.5 wt % chromium alloys, the existence of a hexagonal omega phase (a = 5.02 Å, c = 3.12 Å, c/a = 0.622) in a quenched 2.25 wt % chromium alloy and the appearance, at certain cooling rates, from the β and $\alpha + \beta$ regions of a grain-boundary alpha-like phase. (auth)

2966 LUTETIUM–LEAD SYSTEM. McMasters, O. D.; Gschneidner, K. A. Jr. (Ames Lab., Iowa). J. Less-Common Metals, 19: 337-44(Dec. 1969).

X-ray diffraction, differential thermal, and metallographic methods were used to establish the lutetium–lead phase diagram. A eutectic reaction occurred at 324°C and less than 0.5 at. % Lu as a consequence of lutetium additions lowering the 327°C melting point of lead. The intermetallic compounds $LuPb_3$, $LuPb_2$, and Lu_5Pb_4 decomposed peritectically at 570, 1170, and 1500°C, respectively. Lu_5Pb_4 underwent a polymorphic transformation at 1475°C. Lu_5Pb_3 melted congruently at 1695°C. A eutectic reaction occurred at 1285°C and 17.5 at. % Pb. The solubility of lead in lutetium was about 1.0 at. % Pb at this temperature. The crystal structures of the compounds are discussed. (auth)

2967 ON THE EFFECTS OF IRON AND ZIRCONIUM ON THE EUTECTOID TRANSFORMATION OF COPPER ALUMINUM BINARY ALLOY. Hori, Masaiti (Kanagawa Univ., Yokohama, Japan). Nippon Kinzoku Gakkaishi, 33: 1067-72(Sept. 1969). (In Japanese).

The $\beta \rightarrow \alpha + \gamma_2$ transformation of Cu–Al binary alloy is depressed at cooling velocity 5°C/min and changes to $\beta \rightarrow \beta_1$ and $\beta_1 \rightarrow \beta'$ transformations. The tempering processes of the alloy show combinations of $\beta' \rightarrow \beta_1$, $\beta_1 \rightarrow \alpha + \gamma_2$, $\beta_1 \rightarrow \beta$, $\beta \rightarrow \alpha + \gamma_2$ and $\alpha + \gamma_2 \rightarrow \beta$ transformations, depending on the tempering conditions. The effects of Fe and Zr on cooling and tempering eutectoid transformations and on the self-annealing of Cu–Al binary alloy were measured by means of differential dilatation, differential thermal analysis and microscopic observation. The changes in the length of the columnar structure with the $\beta' \rightarrow \beta_1$ transformation were also discussed. The results obtained show columnar structures of Cu-12.2 Al, Cu-12.3 Al-1.2 Fe and Cu-12.5 Al-1.2 Zr alloys contracted at $\beta' \rightarrow \beta_1$. The $\beta \rightarrow \alpha + \gamma_2$ transformation temperature of Cu-12.3-1.2 Fe alloy was lower than Cu-Al binary alloy and that of Cu-12.5 Al-1.2 Zr alloy was higher. The processes of cooling and tempering transformations of Cu-12.3 Al-1.2 Fe, Cu-12.5 Al-1.2 Zr alloys were the same as those of Cu-Al binary alloy, but microstructures of Cu-12.7 Al-1.0 Fe, Cu-12.7 Al-0.7 Fe, Cu-12.5 Al-1.2 Zr and Cu-12.4 Al-0.7 Zr alloys water-quenched from 800°C were $\beta' + \gamma'$ produced by phase separation. The Al concentrations in these alloys were lower than those in the Cu_3Al type lattices. The self-annealing of Cu-Al binary alloy was depressed by adding Fe and enhanced by adding Zr. (auth)

2968 THE TITANIUM-RICH CORNER OF THE TERNARY Ti–Al–V SYSTEM. Tsujimoto, Tokuzou (National Research Inst. for Metals, Tokyo). Trans. Jap. Inst. Metals, 10: 281-6 (July 1969).

The structures of Ti–4 to 14% Al–2 to 8% V alloys were examined by optical microscopy, after annealing for a long period in the range of 600 to 1100°C. A partial titanium–aluminum–vanadium ternary diagram for this range was established. To distinguish the α and α_2 phases, use was made of the fact that no precipitation from α_1 occurs with decreasing temperature, but α_2 is precipitated from α in the high aluminum alloys. Ti–6% Al–4% V alloy was situated on the boundary for the formation of the α_2 phase. The increase of aluminum or vanadium contents in this alloy brought about the formation of the α_2 phase. (auth)

Radiation Effects

Refer also to abstracts 2941, 3454, 4060, and 4163.

2969 (AD–692072) DAMAGE-FUNCTION ANALYSIS OF NEUTRON-ENERGY AND SPECTRUM EFFECTS UPON THE RADIATION EMBRITTLEMENT OF STEELS. Serpan, C. Z. Jr.; McElroy, W. N. (Naval Research Lab., Washington, D. C.). July 25, 1969. 20p. (NRL–6925). CFSTI.

The results of a new, comprehensive set of experimental data conforming to the irradiated conditions of the derived damage function (material, temperature, and fluence) are presented. The results of this experiment are discussed in terms of their establishing the validity of the damage function. Averaged values of the damage function are tabulated for a typical reactor physics calculation energy group structure, and their application to two different spectra is described. Finally, the damage-function fluences required to cause a 200F Delta-TT in A302-B steel are presented for many different reactor locations. For each of the spectra involved, the upper and lower energy limits of significantly damaging neutrons are given, and some detail is also provided regarding the contribution of subgroups within the overall energy spectrum. (auth) (USGRDR)

2970 (CEA-R–3906) FAST NEUTRON IRRADIATION EFFECTS ON DIFFUSION PROCESSES IN THE ALUMINUM–MAGNESIUM SYSTEMS. Moreau, Guy (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 161p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay, France.

Examination of bulky diffusion couples Al (Mg) – Al and Mg (Al) – Mg between 200 and 440°C out of pile and under fast neutron irradiation show that in the latter case an increase of the growth kinetics of β phase which can be explained using Kidson's formula. An apparent increase of solubility is caused by migration of a part of excess vacancies as complexes to sinks (stacking faults, grain boundaries) or to sub-microscopical clusters. Enhancement of chemical diffusion at low temperature is evident. At infinite dilution, chemical diffusion coefficient of Mg in Al can be expressed in normal conditions as: $\tilde{D} = 1 \exp [(-31{,}000 \pm 1200)/(RT)$ cal/mole] $cm^2 \cdot s^{-1}$ and under irradiation as: $\tilde{D} = 8.10^{-3} \exp [(-24{,}500 \pm 1200)/(RT)$ cal/mole] $cm^2 \cdot s^{-1}$. Interpretation can be carried out by Dienes and Damask's theory. Excess defects (vacancies and interstitials generated in equal numbers by radiation) annihilate by migration to sinks and by direct recombination. Sinks density varies with temperature and irradiation time. The part of complexes (vacancy-solute atom) is important in the vacancies annealing kinetics. (auth)

2971 (ORNL–4470, pp 182–98) MOLTEN-SALT REACTOR PROGRAM. Weir, J. R. Jr.; McCoy, H. E. Jr. (Oak Ridge National Lab., Tenn.).

The MSRE has been critical for 15,425 hr (June, 1969) Surveillance samples of graphite and Hastelloy N have been removed periodically for examination. The samples were mechanically sound and showed no evidence of corrosion. The mechanical properties of the Hastelloy N were measured and the fracture strain was reduced. Advanced molten-salt reactors require improvements in the materials of construction. The addition of small amounts of Ti, Hf, and Nb improve the resistance of Hastelloy N to embrittlement by irradiation, probably through formation of a very fine MC-type precipitate. Corrosion work has focused on the compatibility of Hastelloy N with the new coolant salt, sodium fluoroborate. The higher corrosion rate of this salt is attributed partially to impurities. The dimensional changes of graphite under neutron irradiation pose problems to advanced reactors. Coupling the dimensional measurements with x-ray anisotropy measurements showed that growth rates of the crystallites depend solely upon orientation. Graphites that are dimensionally more stable under irradiation are under development. Techniques were developed for carbon impregnation of graphite with gaseous reactants to achieve the very low gas permeability required for an advanced system. (auth)

2972 (UCRL–71759(Rev.1)) SOME OBSERVATIONS ON 14-MeV NEUTRON RADIATION EFFECTS ON REACTOR MATERIALS. Myers, Blake (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 4, 1969. 36p. (CONF-690901–6). Dep. CFSTI.

From International Conference on Nuclear Fusion Reactors, Culham, England.

The damage that might be expected in the structure of a thermonuclear reactor as inferred by the relative number of displaced atoms with 14 MeV neutrons compared with fission neutrons was investigated. It was found that the lower Z materials studied (Be, C, and Al) might be considered from a radiation effects viewpoint for thermonuclear reactor applications on the basis of fission neutron exposure. There is a modest reservation on this judge-

ment as intermediate neutron energies ($1.4 < E < 14.1$ MeV) were not considered. The higher Z materials (Ni, Nb, and Ta) will have, with thermonuclear neutron bombardment, a maximum of 5 to 8 times the atom displacement rate with fission neutrons at the same flux. These materials are of particular interest for thermonuclear reactors and they should be studied further. A convenient means for such studies seems to be bombardment of these metals with their respective ions or with protons. (auth)

2973 INFLUENCE OF NEUTRON IRRADIATION ON THE CREEP BEHAVIOR OF STEEL 316. Andre, J.-P.; Erler, J.; Malkin, J.; Weisz, M. (Commissariat a l'Energie Atomique de Saclay, Gif-sur-Yvette, France). Mem. Sci. Rev. Met., 66: 553-61 (July-Aug. 1969). (In French).

The creep rate is not greatly affected whatever the metal flow value. Life and ductility are more greatly influenced in proportion to the metal flow. The creep characteristics are nearly identical before and after irradiation. (auth)

2974 DAMAGE FUNCTIONS AND DATA CORRELATION. McElroy, W. N. (Battelle-Northwest, Richland, Wash.); Dahl, R. E. Jr.; Serpan, C. Z. Jr. Nucl. Appl. Technol., 7: 561-71 (Dec. 1969).

A method has been developed for generating damage functions for the correlation and prediction of neutron induced property changes. The method affords a procedure for studying and determining the neutron spectral dependence of irradiation effects data obtained in test reactors, with subsequent application of results to the establishment of more exact engineering design fluence limits for reactor components. The method has been applied to ductile-brittle transition temperature increase data obtained in different test reactor spectra. Results show that neutrons of all energies must be included for best overall interpretation of the experimental irradiation effects data. (auth)

Ceramics and Cermets

Refer also to abstracts 2868, 2869, 2871, 2873, and 2874.

2975 (ORNL-4470, pp 18-22) FUNDAMENTAL CERAMICS RESEARCH. Fulkerson, W. (Oak Ridge National Lab., Tenn.).

A multidisciplinary program of basic research focused on uranium mononitride and related actinide, hard-metal-type compounds has begun to yield significant results. These results include electronic band structure calculations, transport property measurements, cation self-diffusion determination as a function of temperature and nitrogen pressure, and a new method of chemical analysis of nitrogen and carbon by proton reaction. The program involves work both at ORNL and also at several other laboratories using specimens supplied by ORNL. (auth)

2976 FUEL AND FERTILE MATERIALS. Reactor Mater., 12: 221-35 (Winter 1969-70).

Research work on fuel material radiation testing is summarized. Information is included on plutonium oxides, plutonium carbides, uranium carbides, uranium oxides, thorium oxides, uranium nitrides, plutonium alloys, thorium alloys, and uranium alloys. (J.R.D.)

Corrosion and Erosion

2977 (JEN-205-DMe/I-21) INFLUENCE OF THE SILICON CONTENT ON THE CORE CORROSION PROPERTIES OF DISPERSION TYPE FUEL PLATES. Calvo, C.; Saenz de Tejada, L. M.; Diaz Diaz, J. (Junta de Energia Nuclear, Madrid (Spain). Division de Metallurgia). 1969. 27p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

A process to produce aluminum-base dispersion-type fuel plates was developed. The dispersed fuel material is obtained by an aluminothermic process to render a stoichiometric cermet of UAl_3 and Al_2O_3. Various silicon additions have been used in the reactant mixture to avoid any further reaction of the dispersed phase with the aluminum matrix during the plate manufacturing process. Corrosion resistance of the plate core as a function of the silicon content in the dispersed phase was investigated. Specimens with 65 wt % of dispersed material, containing 2, 3 and 5 wt % Si, were exposed to water at 100, 150, and 200°C for various periods of time. The corrosion resistance is strongly influenced by, and increases with, the silicon content. (auth)

2978 (ORNL-4470, pp 208-10) WATER REACTOR SAFETY. Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.).

The coordination of all AEC-sponsored programs on the failure of light-water reactor fuel rods during a loss-of-coolant accident has been undertaken. The reasons for concern over fuel rod failure are discussed along with the scope of the coordinating effort. Tests to evaluate the effects of environmental and material variables on the mode of failure of the fuel cladding are also described. (auth)

2979 OXIDATION AND HYDROLYSIS OF URANIUM AND PLUTONIUM NITRIDES. Bridger, N. J.; Dell, R. M.; Wheeler, V. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 389-400(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Oxidation and hydrolysis processes related to UN and PUN are summarized. Mechanisms of these reactions are analyzed and compared. (J.R.D.)

2980 THE ROLE OF MOLYBDENUM IN THE OXIDATION OF TiC–Ni–Mo ALLOYS. Hachisuka, Takeji (Fujikoshi, Ltd., Toyama, Japan); Nishimura, Tomio; Kondo, Masao. Trans. Jap. Inst. Metals, 10: 271-6(July 1969).

To investigate the oxidation behavior of TiC-base alloys containing molybdenum, TiC–10% Ni and TiC–10% Ni–(2.5 to 18.57)% Mo alloys were prepared by sintering. These alloys were exposed in still air at 600 to 1300°C. The oxidation process and the effect of molybdenum on oxidation were studied by the weight gain, surface recession, x-ray diffraction and microstructure observations of scales. Addition of molybdenum to TiC–10% Ni alloy increased the weight gain due to oxidation below 1100°C, which was most effective at 700 to 800°C. This effect was, however, decreased at higher temperatures and at 1300°C molybdenum increased the oxidation resistance reversely. From the x-ray diffraction data, it appeared that at higher temperatures the oxidation of molybdenum was suppressed to cause the appearance of metallic molybdenum in the scales and $NiO \cdot TiO_2$ was also increased, while at lower temperatures NiO was combined preferentially with $NiO \cdot MoO_3$ and decreased the $NiO \cdot TiO_2$ content in the surface layer of scales. From measurements of the surface recession, it was found that the progress of oxidation of all the alloys at 1000°C was parabolic and the parabolic rate constant increased in proportion to the molybdenum content. But at 1300°C, the surface layer of scales became porous and no parabolic relation was found in all the alloys. (auth)

Preparation and Fabrication

Refer also to abstracts 2342 and 2898.

2981 (ORNL-4470, pp 121-6) RESEARCH REACTOR CORE IMPROVEMENT AND PROCUREMENT ASSISTANCE. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

Providing technical assistance to the AEC Division of Reactor Development and Technology with managing the procurement of research reactor fuel elements was continued. Techniques were developed to roll crush UAl_x fuel in yields of 85 to 90% usable material, compared with 69% by other processes. It was shown that chemical cleaning could enable bonding of type 6061 aluminum to itself, meeting present nonbond specifications. Fuel plates of HFIR geometry were successfully fabricated with a 125% loading of both high-fired and burned U_3O_8. With the modified conditions, inspection problems were encountered. Full-size ATR fuel plates 8 and 19 were fabricated to study dogboning. Dogboning was reduced most effectively by enlarging and weakening the core by adding more aluminum. The calibration curves for the x-ray attenuation homogeneity scanner were extended to higher uranium concentrations and to the use of the burned U_3O_8 fuels. An extensive study of the effects of the processing variables on the sensitivity of radiographic film for determining variations in fuel content has continued. A cost effectiveness plan for determining the total cost of a project similar to increasing the loading of the HFIR fuel element was developed. This computer technique takes into account the various probabilities for success. With HFIR, savings of $3,500,000 or more are predicted. HFIR fuel element production at Metals and Controls has continued on schedule with a minimum of problems. Fuel plate yields for the year were 92.45%, a slight improvement over last year. Waivers are still being required on most fuel elements. Phillips Petroleum Company was assisted with purchasing fuel elements for the Power Burst Facility. Specifications, procurement documents, drawings, and potential contractors have been reviewed. (auth)

2982 (ORNL-4470, pp 127-40) SOL-GEL FAST REACTOR OXIDE FUELS. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

The objective of this program is to obtain an economically optimized $(U,Pu)O_2$ fuel cycle for a Liquid Metal Fast Breeder Reactor (LMFBR) by extending the performance capability and advancing the fabrication technology for oxide fuels. Structures derived from sol-gel processed material are used. Using the Sphere-Pac process, a variety of irradiation capsules containing $(U,Pu)O_2$ microspheres were loaded. Methods were developed for fabrication of pellets from sol-gel-derived material with controlled densities ranging from 80 to 93% of theoretical and with an adjusted oxygen-to-metal ratio of 1.98. Fabrication of two instrumented capsules for testing fuel under power transient conditions in TREAT is reported. Five doubly encapsulated sodium bonded fuel pins for irradiation in EBR-II were fabricated; these capsules are performing satisfactorily. Uninstrumented irradiations in the ETR to 5 at.% burnup and instrumented tests in ORR confirmed that Sphere-Pac fuels will perform in reactors comparably to pelletized fuels of similar smear density. In instrumented tests Sphere-Pac fuels showed thermal conductivities similar to those for pelletized fuels of comparable density. Work on mathematical analysis of irradiation experiments was directed toward the verification of the accuracy of reactor physics and heat transfer analyses. Correlations between experimental results and calculations show that the calculations are accurate and reliable for extrapolation of the probable performance of fuel pins in thermal reactor environments. (auth)

2983 (ORNL-4470, pp 148-59) GAS-COOLED REACTOR PROGRAM. Coobs, J. H.; Scott, J. L. (Oak Ridge National Lab., Tenn.).

All-ceramic nuclear fuels consisting of $(Th,U)O_2$ or $(Th,U)C_2$ particles with composite coatings of pyrolytic carbon and SiC offer considerable advantages as fission-product-retaining fuel for high-temperature gas-cooled reactors. Support for this program consisted of the preparation and irradiation testing, to high fast fluence of coated particles and simulated bonded-bed fuel elements. Testing to fast fluences near the design maximum for HTGR's demonstrated good performance of particles that had isotropic outer coatings with densities between 1.7 and 1.9 g/cm^3, as predicted by a mathematical model. However, fast-neutron irradiation of injection-bonded coated particles resulted in complete debonding or coating breakage. Efforts are now concentrated on preparation of stable fuel elements by careful selection of raw materials and use of other fabrication methods. The corrosion properties in steam at 1100 and 1200°F of nickel alloy weldments proposed for advanced HTGR steam generators were investigated. The aggregates and cast concrete bodies of three mixes being used in mechanical properties studies at other laboratories were characterized. A significant new activity in the program supports the development of fuel elements for a gas-cooled fast breeder reactor (GCFR). The compatibility between fuel and cladding materials at the temperatures and heat ratings proposed for a GCFR are being investigated. The design, fabrication, and examination of irradiation experiments on GCFR fuel pins is in progress. (auth)

2984 (ORNL-4470, pp 204-7) THORIUM UTILIZATION. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

The thorium utilization program is concerned with the use of thorium to economically produce electric power by the thorium-^{233}U fuel cycle. Before the thorium-^{233}U fuel will be practical, new fabrication processes and equipment must be developed to handle the highly radioactive recycle fuel and demonstrated by irradiation in power reactors of fuel fabricated by them. In line with this objective, processes are being developed for remote fabrication of thorium-^{233}U-bearing High-Temperature Gas-Cooled Reactor fuels, to be demonstrated in the recently completed Thorium Uranium Recycle Facility. This facility has already been used for preparing 63 kg of ^{233}U-bearing salt for the Molten Salt Reactor Experiment. Thirty-two kg of Th-^{233}U oxide fuel for the High-Temperature Lattice Test Reactor was also prepared. (auth)

2985 (ORNL-TM-2765) THORIUM FUEL CYCLE DEVELOPMENT PROGRESS REPORT NO. 4, NOVEMBER 1969. (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 14p. Dep. CFSTI.

Efforts in thorium fuel cycle development directed mostly toward HTGR fuels are summarized. Information is included on development of head-end processes for converting irradiated HTGR fuels to a form suitable for recovery and decontamination of the Th and U by solvent extraction. Results of engineering studies of processes and equipment for preparation of ThO_2-UO_3 sols are summarized along with efforts devoted to sphere-forming column chemistry. Other work is reported on fueled graphite particle coating, particle handling, fuel fabrication, fuel element assembly, and inspection. Work on irradiation capsule design, and ^{233}U processing is also reported. (J.R.D.)

2986 (ORNL-tr-2230) PREPARATION OF UO_2 SINGLE CRYSTAL BY INDUCTIONS MELTING. Yajima, Seishi; Furuya, Hirotaka; Aoki, Koichi. Translated for Oak Ridge National Lab., Tenn., from Nippon Genshiryoku Gakkaishi, 10: 632-6(Nov. 1968). 13p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 10257.

2987 FORMATION OF FILAMENTARY SINGLE CRYSTALS OF B, CaB_6, B_4C, AND B_7O. Ahmad, I.; Capsimalis, G. P. (Army Watervliet Arsenal, N. Y.). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 477-86(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Whiskers of boron (beta-rhombohedral and tetragonal) have been shown to grow when boron pieces are heated at 1850 to 1950°C in a pure boron nitride crucible and an inert atmosphere or under vacuum (10^{-3} torr). Whiskers as long as a cm and 5 to 30 microns in diameter were obtained by the former technique. Most of them has an elastic modulus of 60 to 70×10^6 psi, but a few had as high as 90×10^6 psi. The latter whiskers showed strengths approaching 1.3×10^6 psi, the highest ever reported for boron. It has been suggested that these whiskers form by a vapor-liquid-solid mechanism, in which the liquid phase was a solution of nitrogen in boron. In the presence of approximately 2% CaO in the BN, whiskers of CaB_6 formed at 1725°C. Whiskers of B_4C and B_7O were also identified when there were impurities of CO and O_2 in the reaction zone. (auth)

2988 DISPROPORTIONATION OF ZIRCONIUM TRIHALIDES. Shelton, R. A. J.; Bhatti, M. A.; Copley, D. B.; Normanton, A. S. (Univ. of Manchester, Eng.). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 255-60(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Activities are reported in a program for preparation and disproportionation of these compounds in which it is planned to investigate the thermochemical and structural relations between them. Information is included on preparation and disproportionation of ZrI_3, $ZrBr_3$, and $ZrCl_3$. (J.R.D.)

2989 SYNTHESIS AND CRYSTALLITE GROWTH MECHANISM OF SUBMICRON PARTICULATES. Mazdiyasni, K. S. (Wright-Patterson AFB, Ohio). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 115-25(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Hydrolytic decomposition of zirconium alkoxides have resulted in the synthesis of 10 to 50-Å size particulates of active, ultrahigh purity (99.999%) zirconium dioxide. The occurrence of the metastable cubic or metastable tetragonal phases of ZrO_2, as functions of crystallite size and surface energy is demonstrated. A dynamic calcination technique is shown to be most effective in controlling crystallite growth during the presintering stage of processing the submicron powders. The crystallite growth mechanism, in the experiments carried out, may involve first, an atomic rearrangement of powder particles (or grain), and then generation of a nucleus at the interface, which may result in the formation of a larger crystallite. These experimental results suggest that the alkoxy-based method for preparing high-purity submicron oxides and mixed oxides is particularly suited for fundamental studies in the reactivity of fine solids. (auth)

2990 INFLUENCE OF THE GASEOUS ATMOSPHERE ON THE REACTION FOR THE SYNTHESIS OF COBALT TUNGSTATE. Turlier, P.; Perrichon, V.; Trambouze, Y. (Institut de Recherches sur la Catalyse, Villeurbanne, France). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 191-9(1969). (In French).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

The reaction in the solid state between the oxides CoO and WO_3 results in only one solid phase, the cobalt tungstate $CoWO_4$. When fine powders are used, nucleation and intergranular diffusion are the preponderant processes of the synthesis; the solid-gas interface area having been increased. The kinetic study shows that the rate curves are the same in vacuum or under a small pressure of helium or carbon dioxide. The influence of nitrogen on the reactivity of the mixture is weak, but a great increase is observed with water vapor. Study of the reaction using DTA correlates this result, since water vapor lowers the reaction temperature of the mixture. To explain the influence, the quantities of water vapor adsorbed at the reaction temperature have been measured using a microbalance. The results show that water has no evident action on tungstic anhydride, but that this gas is definitely adsorbed by

cobaltous oxide. The intergranular diffusion energy is reduced, and the reaction rate of the mixture increased. (auth)

2991 TRANSPARENT Y_2O_3 BY HOT-PRESSING. Dutta, S. K.; Gazza, G. E. (Army Materials and Mechanics Research Center, Watertown, Mass.). Mater. Res. Bull., 4: 791-6(Nov. 1969).

Transparent Y_2O_3 specimens have been fabricated by vacuum hot pressing in graphite dies at temperatures ranging from 1300 to 1500°C for 1 to 2 hours. Specimens were produced with a grain size of less than one micron. Optical transmittance was greater than 80 percent to six microns in the infra-red. (auth)

2992 PREPARING NICKEL–BORON AND OTHER COMPOSITES FOR OPTICAL-METALLOGRAPHIC EXAMINATIONS. Brassard, Theresa V. (Watervliet Arsenal, N. Y.). Metallography, 2: 293-6(Sept. 1969).

A method for polishing hard boron filaments in soft nickel matrices is described. (J.R.D.)

2993 METHOD OF PRODUCING REFRACTORY COMPOSITES CONTAINING TANTALUM CARBIDE, HAFNIUM CARBIDE, AND HAFNIUM BORIDE. Quatinetz, Max; Weeton, John W.; Herbell, Thomas P. (to National Aeronautics and Space Administration). U. S. Patent 3,472,709. Filed Mar. 25, 1966.

Powders of refractory compounds are uniformly distributed throughout powders of a refractory metal matrix. The resulting mixture is densified by heat and pressure. Solution treatment follows in which a portion of the refractory compound is dissolved into a matrix to form a solid solution which is subsequently uniformly reprecipitated throughout the microstructure. (Offic. Gaz.)

2994 METHOD OF FORMING COMPACTED GRAPHITE BODIES. Wohlberg, Cornel. (to U. S. Atomic Energy Commission). U. S. Patent 3,479,423. Nov. 18, 1969.

A method of forming compacted graphite bodies is described in which graphite powder is mixed with niobium or manganese powder in the atomic ratio of 1 to 100 metal to graphite and thereafter mechanically compacting the mixed powders. (AEC)

2995 FUEL ELEMENT FOR LIQUID-COOLED NUCLEAR REACTORS. Boettcher, Alfred (to Kernforschungsanlage Julich Nordrheim-Westfalen). U. S. Patent 3,472,734. Priority date Oct. 22, 1964, Germany.

A fuel or fertile element is described for a water-cooled or liquid-metal-cooled nuclear-reactor core consisting of a hermetically sealed tubular can of a corrosion-resistant metal (e.g., Zircaloy) and a loosely packed mass of discrete ceramic-coated fuel particles whose cores consist of oxides, carbides, or nitrides of uranium or thorium and whose coatings are composed of at least one from the group of pyrolytic carbon or carbide, carbides of silicon, zirconium, beryllium or niobium, or oxides of beryllium, zirconium, magnesium and aluminum. The can is filled with helium gas at a pressure of 5 to 15 atm (at ambient temperature) and is hermetically sealed so that the liquid coolant of the reactor in contact with the shell is, at the operating temperature of the core, at a pressure substantially equal to the pressure of the gas within the can. The coated-particle fuel may be mixed with a pulverized ceramic filler of high thermal conductivity from the group of carbon, carbides, and oxides previously listed. (Offic. Gaz.)

2996 LOW TEMPERATURE PROCESS FOR PYROLYTIC DEPOSITION OF ZIRCONIUM OXIDE FILMS. Barnes, Charles R. (to Secretary of the Air Force). U. S. Patent 3,472,680. Filed Sept. 21, 1967.

A process and apparatus are described for depositing at 600 to 650°C and at one atmosphere of pressure, dielectric ZrO_2 films on refractory metal alloys of molybdenum and tantalum from vaporized zirconium tetrachloride and phosphorous oxychloride with hydrogen reducing gas and nitrogen carrier gas. (Offic. Gaz.)

2997 POROUS UO_2 BODIES PRODUCED BY REDUCTION OF U_3O_8. Washburn, T. N. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol., 8: 23-8(Jan. 1970).

Porous UO_2 microspheres, or kernels, can be produced by reduction of fired U_3O_8 kernels to the lower oxidation state. The temperature at which the U_3O_8 kernel is fired is a major parameter in establishing the degree of porosity, and subsequent reduction from the U_3O_8 state must be carefully controlled to prevent formation of internal cracks. Restricting the furnace temperature to less than 1000°C and providing small incremental increases in the quantity of reducing gas added to the furnace inert atmosphere produced well-distributed porosity in the ceramic body without creating cracks in the internal structure of the kernel. (auth)

2998 PHENOMENA OCCURRING DURING THE COMPACTION OF CERAMIC POWDERS, WITH PARTICULAR REFERENCE TO FURTHER COMMINUTION. Bumm, H.; Liepelt, H. (Kernforschungszentrum, Karlsruhe, Ger.). Ber. Deut. Keram. Ges., 46: 540-7(Oct. 1969). (In German).

The pressure applied during the shaping of ceramic oxides (Al_2O_3, ZrO_2, MgO) has an appreciable effect on the grain size and specific surface of the initial powder. The comminution of such powders during pressing was studied partly by sieve analysis and partly by determining the specific surface using the B.E.T. method. Additives (to facilitate the shaping process) affect both compaction and grading of the powder. While there were differences in the degree of compaction attainable with the three different materials (i.e., alumina, zirconia and magnesia), they all showed a similar behavior with regard to their comminution. Even small pressures are sufficient to cause perceptible changes in the grain-size curves, the effect increasing with increasing shaping pressure. Under the conditions investigated the die pressing results in a greater comminution than does the isostatic pressing. Using polished sections of pressed specimens comminuted particles can be made visible under a microscope. A model of the phenomena occurring during pressing is proposed and supported by various experimental findings. (auth)

Properties Evaluations

Refer also to abstracts 2167, 2922, 2926, 2930, 2935, 2987, and 3471.

2999 (BM-RI-7323) HEATS OF FORMATION OF THREE OXIDES OF RHENIUM. King, Edward G.; Richardson, D. W.; Mrazek, R. V. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Nov. 1969. 13p. Bureau of Mines Free.

Heats of formation of ReO_2, ReO_3, and Re_2O_7 have been determined by the method of solution calorimetry, using an aqueous perchloric acid–ceric perchlorate solvent. Copper metal and cupric oxide were utilized as auxiliary substances. Heats were determined at 298°K for the reactions $Re + 2CuO = ReO_2 + 2\,Cu$, $Re + 3CuO = ReO_3 + 3Cu$, and $2Re + 7CuO = Re_2O_7 + 7Cu$. Standard heats of formation were derived using the value of -37.23 ± 0.15 kcal/mole as the heat of formation of CuO. The standard molal heats of formation of the rhenium oxides were determined as ReO_2, -107.3 ± 0.8 kcal; ReO_3, -140.8 ± 0.9 kcal; and Re_2O_7, -301.9 ± 1.8 kcal. (auth)

3000 (INR-756) PAR-1; AlMgSi-ALLOY FOR THE ELEMENTS OF NUCLEAR REACTORS. Bochenek, Bronislaw; Szulc, Leszek (Institute of Nuclear Research, Warsaw (Poland)). Oct. 1966. 20p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The results of investigations of the chemical composition and macrostructure of PAR-1–alloy are described. High purity and high chemical homogeneity were confirmed. (auth)

3001 (NYO-3886-4) IMPROVED COMPATIBLE MATERIALS FOR THERMOELECTRIC POWER GENERATION. Final Report. Dismukes, J. P.; Kudman, I.; Moss, H. I. (RCA Labs., Princeton, N. J.). Aug. 1969. Contract AT(30-1)-3886. 40p. Dep. CFSTI.

During this period, the major effort of research on PbTe alloys was concentrated on improving hot-pressing procedures so that multi-sample pressing would reproducibly provide desired thermoelectric properties, and on extensive life-testing of the multi-sample hot-pressed material. In addition, in-gradient life tests, high-temperature thermoelectric measurements, and thermocouple efficiency measurements were carried out. As a result of a comprehensive series of experiments, the problems previously observed with hot-pressed material were eliminated. Samples of both n-type PbTe-GeTe alloys and p-type PbTe-PbSe alloys can now be reproducibly hot-pressed with a figure-of-merit over the entire temperature range of 25 to 525°C, essentially equivalent to that of melt-grown material. Several hot-pressed samples of n-type $Pb_{0.95}Ge_{0.05}Te$ and $Pb_{0.975}Ge_{0.025}Te$ alloys have shown excellent stability on isothermal life-testing in vacuum at 525°C for time periods of 1000 to 2000 hours. However, one sample of a $Pb_{0.95}Ge_{0.05}Te$ alloy has shown an increase in resistivity and Seebeck coefficient after 2400 hours. This is attributed either to contamination or to impurity precipitation. Hot-pressed p-type $PbTe_{0.95}Se_{0.05}$ alloy samples have shown good stability on isothermal life test in vacuum at 525°C for 1000 hours. These results indicate that continuation of the life-testing program is desirable. In particular, studies of life-test properties of alloys with decreased (2.5 to 5%) GeTe concentration are recommended. Furthermore, it is recommended that isothermal life testing should be carried out in an inert gas, rather than vacuum, and special efforts should be made to avoid oxygen contamination during life testing. Studies of in-gradient life testing have shown that an

isothermal life test at 525°C is a more severe test than an ingradient test between 25 and 525°C, since degradation decreases with decreasing temperature. Finally, a thermocouple was fabricated, and operated between 25 and 525°C. An efficiency of only 6.7% was measured because of the high contact resistance. Nevertheless, the results corroborated the previous high-temperature measurements of Q, ρ, and k. (auth)

3002 (ORNL-4470, pp 12-13) DIFFUSION IN SOLIDS. Lundy, T. S. (Oak Ridge National Lab., Tenn.).

Cation self-diffusion coefficients have been measured by use of the tracer ^{233}U and the alpha-energy degradation method for the nuclear fuels UO_2 and UN_{1+x}. The relative importance of lattice and short-circuit diffusion in these fuels and in refractory metals, including tungsten were considered. Lattice diffusion coefficients for three tracers in tungsten were measured over the range 1300 to 2400°C and found to obey Arrhenius relations very accurately. A mathematical analysis was made for combined surface and grain boundary diffusion. The influence of oxidation on the previously observed near-surface effect was explored and found capable of explaining this effect. Residual activity methods for measurement of diffusion coefficients were critically examined with data obtained by use of the highly precise anodizing-and-stripping technique. (auth)

3003 (ORNL-4470, pp 34-42) SPECTROSCOPY OF IONIC MEDIA. Smith, G. P. (Oak Ridge National Lab., Tenn.).

Absorption spectra of molten salts are giving details about the structures of ionic entities in melts. Results concern the nature of nickel complexes and bismuth species in molten halides, methods for studying molten fluorides, and observations on related solids. (auth)

3004 (ORNL-4470, pp 76-84) NITRIDE FUELS DEVELOPMENT. Scott, J. L.; Patriarca, P. (Oak Ridge National Lab., Tenn.).

Nitride fuels are being developed for space-nuclear and liquid-metal fast breeder reactors (LMFBR). Properly designed (U,Pu)N LMFBR fuel pins can operate at significantly higher linear heat ratings and power densities than can mixed oxides. Nitride fuels also appear more fabricable and more compatible with cladding alloys than are carbides. A program which includes synthesis, fabrication, characterization, thermodynamic studies, compatibility studies, and irradiation testing is reported. Processes for fabricating various sizes and shapes, development of powder characterization methods and equipment improvement are described. Specimens of $U^{15}N$ were prepared for irradiation and other tests. Synthesis and fabrication of mixed (U,Pu)N began. Conversion of sol-gel oxide to carbonitride was greatly enhanced when carbon was incorporated in the sol. The kinetics of sol-gel conversion reactions are studied in detail to optimize efficiency. Compatibility and thermodynamic studies dealing primarily with vanadium-base LMFBR cladding alloys are described. The effects of oxygen contamination, temperature gradients, and nuclear burnup on compatibility were investigated. Oxygen contamination may be desirable in nitride fuels because it can reduce twenty-fold the nitrogen pressure in $UN-U_2N_3$ and thus might prevent reaction with the cladding. The existence of UVC_2 was confirmed and evidence for a more active form of carbon in the V-C-N system was found. To determine its basic irradiation behavior under LMFBR conditions UN was irradiated at central fuel temperatures of 1200 to 1400°C to a burnup of 1.8 at.%. Cladding restraint significantly reduced fuel swelling. (auth)

3005 (WANL-TME-1941) GRAPHITE THERMAL EXPANSION REFERENCE FOR HIGH TEMPERATURES. Gaal, P. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). July 1969. 73p. Dep. CFSTI.

The design requirements of the aerospace and high temperature nuclear reactor industries necessitate reliable thermal expansion data for graphite and other carbonaceous materials. Currently there are no accepted standards or reference materials which can be used in carbon-rich atmospheres at temperatures ranging to 2500°C. The feasibility of an acceptable reference for calibration of expansion measuring systems that operate in such test environments (furnaces utilizing graphite heaters, for example) is discussed. The contention of the study is that present-day graphite technology provides acceptable materials for stable, reproducible references, as reflected by some of the candidate materials. The repeatability for a single specimen in a given expansion measuring system was found to be ±1%, while the combined results of several tests made on a number of samples fell within a ±2.5% bond. Data and results of testing on several grades of candidate graphites are given. (auth)

3006 THERMOCOUPLE CEMENTS FOR NUCLEAR ROCKET ENGINE NOZZLES. Barron, Saul (State Univ. of New York, Buffalo). Amer. Ceram. Soc. Bull., 48: 770-4(Aug. 1969).

Selection of an electrical insulating cement for use in the high temperatures of the exhaust nozzle of a nuclear rocket engine was considered. The cement was to be used to attach miniature thermocouples to the 0.010 in. thick wall of the Type 347 stainless steel tubes in the exhaust nozzle of a nuclear rocket engine. The thermocouples were to be placed on the gas side of the tubes. Environments included temperature and pressure excursions ranging from −424 to 2000°F, and pressure differentials up to 750 psi. From a literature survey, property data were compiled for candidate materials. Analytical methods were developed to evaluate present as well as proposed materials in terms of thermal conductivity, bond, tensile, and compressive strengths. The greatest deterent to the use of most of the materials surveyed was due to stresses set up from mismatch effects resulting from widely separated thermal coefficients of expansion. The most promising materials were ZrO_2, MgO, MgO + 50% carbonyl Fe, Al_2O_3 + 50% carbonyl Fe, Al_2O_3, and boron nitride. Materials studied included oxide ceramics, cermets, borides, nitrides, carbides, porcelain enamels, silicides, and unclassified commercially available cements. (BBB)

3007 METALLOGRAPHIC PREPARATION OF SOME PLUTONIUM–URANIUM FUEL MATERIALS. Smith, F. M.; Mayhan, S. J.; Olson, R. V. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Metallography, 2: 179-89(Sept. 1969).

Unirradiated plutonium-bearing ceramic fuel materials are prepared for ceramographic examination in a dry nitrogen atmosphere, gloved facility. The compartmented box is arranged so that spread of grit and alpha activity is minimized. Photomicrography is done in an open-faced hood enclosure attached to a metallograph stage. In addition to the techniques normally used, support work is done in preparing samples for use on the electron microscope, scanning electron microscope, electron microprobe, dilatometer, and x-ray diffraction instruments. Chemical etchants are included for PuO_2 and mixed uranium-plutonium oxides and nitrides. (auth)

3008 NATURE AND HEAT PRODUCTION BY AMORPHOUS HYDRATED ZIRCONIUM OXIDE. Livage, J.; Vivien, D.; Mazieres, C. (Univ., Paris). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 271-80(1969). (In French).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Dehydration of a hydrous precipitate of zirconium oxide first leads to an amorphous oxide of high reactivity. Heated in an oxygen-free atmosphere, this oxide crystallizes into a black powder of a relatively stabilized tetragonal structure, with a O/Zr ratio lower than 2. The reason for this nonstoichiometry is not yet clearly understood, but it is obviously related to the small size and the peculiar organization of the particles before heating. The structure of amorphous zirconia was studied by x-ray and neutron diffraction. A two-dimensional structure made of Zr atom plates (diameter of about 20 Å) is evident, with an oxygen layer on each side of these plates similar to the O and Zr arrangement of the (111) plane of tetragonal ZrO_2. Initially, the water remaining in the precipitate is bound to the surface. During a thermal treatment, a new type of proton appears which could be attributed to free water molecules. These water molecules might be enclosed in microcavities formed in the growing tetragonal phase. The shift of NMR lines with the temperatures of the sample suggests an interaction between the superficial water (as opposed to the water in the microcavities), and some paramagnetic defects which appeared (as shown by ESR experiments) during the previous thermal treatment. (auth)

3009 OXIDATION OF URANIUM–CARBON ALLOYS. Moreau, C.; Philippot, J. (CEN, Grenoble, France). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 377-88 (1969). (In French).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

The behavior of U–C alloys in oxidizing atmospheres of oxygen, water vapor, and carbon dioxide was systematically studied to determine the role of temperature and pressure and, in the case of oxygen, of carbon content and excess temperature. The results showed that the evolution of the texture of the product by increase of the temperature provokes the passage from the linear regime to the parabolic regime. In the case of oxygen and carbon dioxide these linear regimes are probably pseudolinear with ionic diffusion processes in a layer which, because of the formation of gaseous products, can be compacted very little. The limiting step of the mechanism of the three reactions with the gases should be the same: the diffusion of interstitial O^{2-} ions into UO_2, more or less stoichiometrically. The role played by the pressure seems to con-

firm this hypothesis. The stoichiometry of this UO_2 oxide depends on the nature of the gases released, on the quantity of the carbon content, and its compactness. It affects the measured values of the activation energy: the highest (55 kcal mol^{-1}) was found in the case of the most reducing medium (UC + H_2O), where the oxide was closest to stoichiometry. The UC + O_2 reaction leads to the lowest value (22.5 kcal mol^{-1}), and the UC + CO reaction has an intermediate value (42.5 kcal mol^{-1}). The real reactivity of the uranium carbide with respect to the carbon dioxide is low: at 700°C, for example, under normal pressure it is 85 times less than that under oxygen. (tr-auth)

3010 NONMETALLIC THERMOCOUPLES AND SHIELDING TUBES. PART 1. MATERIALS AND THEIR PROPERTIES. Samsonov, G. V.; Kisly, P. S. VDI (Ver. Deut. Ing.) Z., 111: 1337-42(Oct. 1969). (In German).

For the manufacturing of shielding tubes for thermocouples especially high-melting compounds, e.g., carbides, borides, silicides, and nitrides- are suited due to their chemical resistance in various corrosive media. Shielding tubes made of a zirconium diboride molybdenum alloy, for instance, allowed the measuring of temperatures in steel melts with thermocouples. High-melting compounds also could be used as materials for thermocouples. Therefore, the C-TiC as well as the C-ZrB_2 thermocouple showed a remarkable stability especially in a temperature range from 2000 to 2500°C due to the fact that at the measuring place (hot junction of the couple) no mass migration could occur from leg of the couple junction into the other leg. (auth)

3011 RATE AND HEAT OF VAPORIZATION OF GRAPHITE ABOVE 3000°K. Clarke, J. T.; Fox, B. R. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 51: 3231-40(Oct. 15, 1969).

The rate of vaporization of graphite filaments has been measured from 2500 to 3400°K in vacuum and in He by pulse heating techniques. At 3400°K, the rate of vaporization was sufficiently high that a direct determination of the heat of vaporization could be obtained. The experimental results have been correlated with thermodynamic data obtained at lower temperatures on graphite and its vapor species; the predominance of C_2 in vaporizing graphite is shown to satisfy the experimental results. The specific surface area of the filaments was measured and interpreted. (auth)

3012 ELECTROPHYSICAL PROPERTIES OF LANTHANUM CHROMITE AND ITS CERAMICS. Gordon, V. G.; Spiridonov, E. G. Ogneupory, No. 5, 46-9(May 1969). (In Russian).

Studies were made of the electrophysical properties of lanthanum chromite, and lanthanum chromite with zirconium dioxide stabilized by lanthanum oxide in the temperature range from 20 to 1100°C and 900 to 2000°C. (tr-auth)

3013 SINTERING KINETICS OF ZIRCONIUM DIOXIDE. Andreeva, N. A.; Gropyanov, V. M.; Kozlovskii, L. V. Ogneupory, No. 5, 51-7(May 1969). (In Russian).

The kinetics of zirconium dioxide sintering was studied in relation to the purity of the material and the imperfections in the crystalline lattice. The investigation was conducted on monoclinic pure, highly pure, and nonstoichiometric zirconium dioxide. Despite significantly lower values for the energy of activation for highly pure and nonstoichiometric zirconium dioxide, the sintering took place slower than that for pure and stabilized zirconium dioxide. (tr-auth)

3014 STUDY OF STRONTIUM ZIRCONATE HOT PRESSING. Shakhin, V. S.; Bogdanov, N. I.; Balkevic, V. L. Ogneupory, No. 5, 41-5(May 1969). (In Russian).

Dense specimens of strontium zirconate were prepared by hot pressing. The increased density of strontium zirconate powder occurred at temperatures above 1400°C. The maximum density of specimens of 99.6 percent purity was reached at the hot pressing temperature of 1450 to 1500°C, under pressure of 200 to 300 kg/cm^2, for 30 minutes. (tr-auth)

3015 VIBRATION COMPACTED UO_2 FUEL. IV. MECHANICAL RESPONSE OF VIBRATING FUEL ROD. Hirose, Yasuo; Takeda, Seiji (Hitachi, Ltd., Ibaraki, Japan). J. Nucl. Sci. Technol. (Tokyo), 6: 557-66(Oct. 1969).

A study of the effects brought upon the mechanical response of vibration compacting cladding tubes by differences in the powder loading is described. The fundamental frequency of the tube decreases with increasing mass of powder loading. This relation can be explained by assuming that the mass of powder is rigidly fixed to the tube wall. The peak magnification factor at resonance also decreases with increasing powder mass. The maximum intensity of stress is found at the bottom of the cladding and the stress distribution is sinusoidal. Random wave vibration produces in the cladding tube a peak stress only about half the intensity of that by sinusoidal wave of the same root mean square level, and may thus be a promising approach to effective compaction with smaller stresses imparted to the cladding material. (auth)

3016 NEW INVESTIGATIONS INTO THE PLASTIC BEHAVIOUR AND FRACTURE OF HARD METALS. Burbach, J. (Zentralinstitut fuer Forschung und Entwicklung, Essen). Tech. Mitt. Krupp, Forschungsber., 26: 71-80(Oct. 1968). (In German).

The use of a hard upsetting tool enables the behavior of low-ductility materials during deformation and fracture to be determined with very small error. In all tungsten carbide-cobalt alloys (6 to 30% Co), clearly measurable plastic deformation occurs before fracture takes place. This plastic deformation is present in either phase and increases with the cobalt content and the mean particle diameter of the tungsten carbide. The elastic energy stored in the specimen is not sufficient for immediately propagating an existing or incipient crack to the point where the specimen fractures. Prior to the fracture, the crack propagates under constant energy input from the testing machine, while the yield stress decreases at the same time. Upon fracture, shear surfaces occur which are covered with a tungsten, carbon and cobalt-containing layer of unknown structure. (auth)

3017 TORSIONAL DAMPING IN PYROLYTIC GRAPHITE. Firle, Tomas E. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. Carbon, 7: 595-607(Oct. 1969).

The damping and shear modulus changes of pyrolytic graphite were studied by internal friction techniques in torsion in the 10-c/s frequency range. The temperature dependence of internal friction and modulus defect was determined from about 50° to 300°K under stable and reversible conditions. Two broad peaks were found at 135° and 250°K. Correlating these peak temperatures with data from the literature and assuming a thermally activated process, $f = f_0 \exp(-H/RT)$, leads to activation parameters of 0.40 eV ($\log f_0$ = 15.5) and 0.58 eV ($\log f_0$ = 12.5), respectively. The reproducible amplitude dependence was explored, for the same temperature range, for strains from $\sim 10^{-7}$ to about 5×10^{-5}. A comparison with data from the literature for graphites and other materials by way of the Granato-Luecke approach shows only a qualitative fit into the ordering scheme but no definite break-away characteristics. (auth) (UK)

3018 ACOUSTIC EMISSION FROM GRAPHITE UNDER STRESS. Gilchrist, K. E. (United Kingdom Atomic Energy Authority, Culcheth, Eng.); Wells, D. Carbon, 7: 627-31(Oct. 1969).

Results are given of acoustic emission tests on samples of extruded PGA and isotropic graphites during compression testing and during stress cycling. Derived valves are obtained for changes in Poisson's ratio with compressive load. (UK)

3019 THE RELATIONSHIP BETWEEN THE THERMAL CONDUCTIVITY AND CRYSTAL STRUCTURE OF β-RHOMBOHEDRAL BORON. Petrov, A. V.; Germaidze, M. S.; Golikova, O. A.; Kiskachi, A. Yu.; Matveev, V. N. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 11: 741-4 (Oct. 1969).

Translated from Fiz. Tverd. Tela, 11: 907-10(Apr. 1969).

The thermal conductivity of four samples of β-rhombohedral boron was measured in the temperature range 80 to 1100°K. Two anomalies of the thermal conductivity of this modification of boron were observed: a low absolute value of the conductivity and its independence of temperature at T > 600 to 700°K, although at low temperatures the thermal conductivity had a maximum typical of all the crystal structures of boron. These features of the thermal conductivity of β-rhombohedral boron were attributed to the complexity of its structure, because of which it was possible to take into account separately the contributions of long- and short-wavelength phonons with different temperature dependences of the mean free path. (auth)

3020 SPECIFIC HEAT AT LOW TEMPERATURE FOR SEVERAL CaB_6 TYPE HEXABORIDES. Mercurio, Jean-Pierre; Etourneau, Jean; Naslain, Roger; Bonnerot, Jacques (CNRS, Bordeaux. CNRS, Orsay, France). Compt. Rend., Ser. B, 268: 1766-9(June 30, 1969). (In French).

The cubical hexaborides MB_6 (M = Th, La, Yb) with the CaB_6 structure were prepared beginning with high purity boron either by direct synthesis or by reduction of the corresponding oxides. Their specific heat was studied between 2 and 12°K by adiabatic calorimetry. The results obtained for ThB_6 and LaB_6 showed the existence of an electronic specific heat which confirms the metallic character of the hexaborides MB_6, where M is a metal with an upper valence of 2. The thermal behavior of YbB_6, where ytterbium seems to have the valence 2, is analogous to that of a semiconductor. (tr-auth)

3021 MAGNETIC AND CRYSTAL STRUCTURES OF THE TRIGONAL Tb_2C. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys., 51: 3872-6(Nov. 1, 1969).

Neutron powder-diffraction measurements have shown that Tb_2C is isostructural with Y_2C, i.e., crystallizes with an anti-$CdCl_2$-type trigonal structure ($D^1_{3d}-R\bar{3}m$), having the following crystallographic parameters in the hexagonal coordinates: the unit-cell dimensions, a = 3.595 ± 0.006Å and c = 18.19 ± 0.03 Å at 300°K; three Tb_2C formula units per unit cell; z_{Tb} = 0.2593 ± 0.0006; and z_C = 0. Tb_2C becomes ferromagnetic below T_c = 266 ± 2°K. The ordered moments are directed along the trigonal c axis, and the saturation moment is 8.6 ± 0.2 μ_B per Tb. The temperature variation of the ordered moment in the range 260°K < T_c < 5°K is represented by $8.6[1-(T/T_c)^2]$ in Bohr magnetons. The ferromagnetic ordering accompanies a small-angle magnetic scattering inferring an additional ordered moment with the modulation repetition of roughly 100 Å. The maximum composite ordered moment is estimated to be about 9 μ_B, the value expected for the free Tb^{3+} ion. (auth)

Structure and Phase Studies

Refer also to abstracts 2167, 2943, 2945, 2951, 2955, and 3002.

3022 (JUL-589-RW) ESTIMATION OF THE AMORPHOUS PART IN PYROLYTIC CARBON WITH THE HELP OF AN OPTICAL METHOD. PART I. Koizlik, K.; Schulze, H. A.; Gruebmeier, H. B.; Scheidler, G. P. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Apr. 1969. 19p. (In German). Dep. CFSTI (U. S. Sales Only).

The orientation anisotropy of pyrolytically deposited carbon layers is usually determined by x-ray. A previously used light-optical determination is based on the refraction measurement by means of a microscope photometer on pyrolytic carbon to establish relations between the optically measured and x-ray determined anisotropy factors. The necessity of modifying this relation is shown. The equation is expanded so that it can be used to consider the structure of pyrolytically deposited carbon originating both as amorphous and crystalline carbon. Since the amorphous fraction is given only in the optically determined anisotropy factor, the combination of both methods permits an estimation of the amorphous fraction. (tr-auth)

3023 (KFK-1011) TERNARY URANIUM-TRANSITION METAL NITRIDES. Holleck, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). July 1969. 13p. (CONF-690631-1). Dep. CFSTI (U. S. Sales Only).

From 3rd International Conference on Solid Compounds of Transition Elements, Oslo, Norway.

A review of ternary uranium-transition metal nitride properties and phases is presented. Comparisons are made in some cases between the nitrides and corresponding carbides. Emphasis is placed on the complex nitride phases involving U-V-N, U-Nb-N, and U-Cr-N. (J.R.D.)

3024 (ORNL-4470, pp 1-4) CRYSTAL PHYSICS. Clark, G. W. (Oak Ridge National Lab., Tenn.).

Crystals of refractory materials are being grown by internal centrifugal zone growth, from molten salt solvents, by temperature-gradient zone melting, from supercritical aqueous systems, and by the general Verneuil method. Some have been used by researchers of several disciplines. Manganese gallium ferrite crystals were grown and found favorable as a neutron beam polarizer but improvement of crystal perfection is needed by improving an internal centrifugal zone growth technique the size of UO_2 crystals was increased to 1.3 cm in diameter × 2.2 cm long. To study the morphological and epitaxial characteristics of the UO_2-W eutectic structure, a technique was developed for selectively etching away the UO_2 matrix. This study is now in progress using a scanning electron microscope and x-ray techniques. Graphite crystals were grown in the carbon-nickel system by the temperature-gradient zone melting method. Single crystals of $^{237}NpO_2$ were grown up to 2 × 2 × 3 mm in size. For electron spin resonance studies crystals were grown of $HfSiO_4$ doped with Tb^{4+} or Yb^{3+}; $SrCl_2$ doped with ^{241}Am, ^{244}Cm, or ^{245}Cm; and ThO_2 doped with ^{151}Eu, ^{153}Eu, ^{241}Am, ^{243}Am, or Tl. Conditions favorable for the epitaxial growth of PbS were determined. The temperature dependence of the magnetic susceptibility of NpO_2 single crystals was measured from 77 to 800°K. An unexplained change of slope was observed near 300°K. (auth)

3025 (ORNL-4470, pp 28-9) PHYSICAL CERAMICS STUDIES. Morgan, C. S. (Oak Ridge National Lab., Tenn.).

Analysis of dislocation behavior during deformation of single-crystal UO_2 specimens is being extended to hyperstoichiometric crystals. Activation energies determined during short-term sintering tests are not compatible with a diffusion-controlled process, suggesting material transport by a mechanism not diffusion controlled. The cause of loss of density in sintered specimens during long heating periods is being studied. The deformation of polycrystalline UN under controlled nitrogen pressure is being investigated. (auth)

3026 CRYSTAL STRUCTURE OF Lu_2TeO_6. Malone, J. A.; Dorrian, J. F.; Muller, O.; Newnham, R. E. (Pennsylvania State Univ., University Park). J. Amer. Ceram. Soc., 52: 570(Oct. 21, 1969).

Observed x-ray diffraction patterns are described which show that Lu_2TeO_6, Sc_2TeO_6, and In_2TeO_6 are isostructural with Na_2SiF_6. (J.R.D.)

3027 SKELETON NETWORK OF ALUMINA IN Al-Al_2O_3 ALLOYS. Beghi, G.; Cazzaniga, E. (EURATOM, C. C. R., Ispra, Italy). Metallography, 2: 283-7(Sept. 1969).

Work directed toward confirmation of a hypothesis that the microstructure of SAP consists of a continuous Al_2O_3 network interpenetrating an aluminum matrix is reported. The method used consists of dissolving the Al matrix from SAP containing various percentages of Al_2O_3. (J.R.D.)

3028 A RAPID DENSITOMETRY METHOD FOR DETERMINING PREFERRED ORIENTATION OF PYROLYTIC CARBON. Chaney, C. L.; Powell, K. F. (Gulf General Atomic Inc., San Diego, Calif.). Metallography, 2: 227-37(Sept. 1969).

A detailed description of a rapid densitometry method, which reduces the time to determine the preferred orientation of carbon crystallites from x-ray diffraction photographs by a factor of 30, is presented. (auth)

3029 MICROSTRUCTURE OF ELECTRIC DISCHARGE MACHINED WC-Co. Filimonenko, V. N.; Gurland, J.; Richman, M. H. (Inst. of Electrical Engineering, Novosibirsk, USSR. Brown Univ., Providence). Metallography, 2: 125-36(Sept. 1969).

The electrical discharge machined surfaces of several sintered WC-Co alloys were examined at room temperature by x-ray diffraction and optical and electron microscopy. In addition to the hexagonal WC, both W_2C and the face-centered-cubic modification of WC were found. The relative amounts of W_2C and WC (fcc) vary versely with capacitance. Upon annealing, both disappear and are replaced by the η-phase (W_3Co_3C). Certain features of the microstructure are tentatively associated with the extraneous phases, but further interpretation of the x-ray and metallographic results requires a more specific study of the respective roles of cobalt and carbon in the surface reactions. (auth)

3030 FIELD ION MICROSCOPY OF CARBIDES OF TUNGSTEN FORMED EXTERNALLY AND IN SITU. Richman, M. H.; Sproul, W. D. (Brown Univ., Providence). Metallography, 2: 149-59 (Sept. 1969).

The field ion images of carbides of tungsten produced by in situ and external carburization processes are compared for the compounds W_2C and WC. In both cases it is found that the ion images are identical and that they correspond to the crystal structure normally associated with the bulk forms of these two compounds. (auth)

3031 INVESTIGATION OF PARTICLE SIZE ANALYSES AS APPLIED TO WC-Co. Butler, T. W. (U. S. Naval Academy, Annapolis). Metallography, 2: 289-92(Sept. 1969).

Models of WC-Co matrices are analyzed with special attention directed toward the WC particle size effects. (J.R.D.)

3032 INFLUENCE OF SOME HETEROVALENT IONS AND THE NATURE OF THE ATMOSPHERE ON THE REACTIVITY IN THE SOLID STATE OF FINELY DIVIDED ANATASE. Vergnon, P. G.; Astier, M. P.; Juillet, F. E.; Teichner, S. J. (Institut de Recherches sur la Catalyse, Villeurbanne, France). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 137-48(1969). (In French).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

The reactivity of fine particles of pure titanium dioxide or titanium dioxide containing heterovalent cations is shown by the crystalline transformation rates and the high densification rates of compresses made with these particles. The transport of matter during contraction is controlled by the interstitial diffusion of Ti^{3+} ions. The activation energy of the contraction (23 kcal/mol) is the same regardless of the nature of the atmosphere (vacuum, air,

nitrogen) and is not modified by the presence of antimony or gallium cations at a content of the order of 300 ppM. It corresponds to the value found for the activation energy for the diffusion of Ti^{3+} ions in rutile. The rate of the contraction is increased under vacuum or in nitrogen for all the samples; this is related to the increased concentration in Ti^{3+} ions. The presence of antimony also increases the concentration of Ti^{3+} ions and leads to higher shrinkage rates. The presence of gallium does not affect the contraction. The final densification of the compress is probably limited by an occluded porosity which is related to the magnified migration of the grain boundaries. The gallium ions are probably deposited at the grain boundaries and decrease their exaggerated migration, allowing greater densification. When the rate of the contraction is increased either by the presence of antimony or by an increase of the fritting temperature, the exaggerated swelling of the grains leads to a stabilization of the densification after the anneal period. (tr-auth)

3033 FAULTING IN INDIUM PHOSPHIDE GROWN ON GERMANIUM. Holloway, H. (Ford Motor Co., Dearborn, Mich.). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 453-9(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Investigations of stacking disorder in thin layers of InP reveal that specimens grown epitaxially by HCl transport have disordered stacking of close-packed planes. The electron diffraction patterns obtained can only be interpreted in terms of heterogeneity in the fault concentrations. The observed intensity distributions indicate at least two types of regions. One with almost random stacking of close-packed planes and the other with disorder but with stacking sequences which are statistically much closer to sphalerite. From the occurrence of close-packed directions along $\langle 1, 1, 1\rangle$ axes of twins it is deduced that there are also regions of perfect cubic stacking. (auth)

3034 DIRECT PHASE TRANSFORMATION IN CARBON. Bundy, F. P. (General Electric Research and Development Center, Schenectady, N. Y.). Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 817-26(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Discussions of solid-solid transitions between graphite and cubic diamond are presented. Information concerning the transition from graphite to wurtzite diamond is included. The mechanisms involved in diamond–graphite transformations at low to medium temperatures and at higher temperatures are reviewed. (J.R.D.)

3035 TEMPERATURE OF PHASE TRANSFORMATION OF BERYLLIUM OXIDE. Kocherzhinskii, Yu. A.; Shishkin, E. A.; Yupko, L. M. Ogneupory, No. 5, 50(May 1969). (In Russian).

Studies on the phase transformation of beryllium oxide determined by differential thermal analysis showed that it takes place during heating at 2075 ± 15°C. (tr-auth)

3036 VARIATIONS IN THE CRYSTALLINE PARAMETERS IN THE SOLID SOLUTION α-ZIRCONIUM-OXYGEN AS A FUNCTION OF THE OXYGEN CONTENT. Boisot, Pierre; Beranger, Gerard (CNRS, Paris). Compt. Rend., Ser. C, 269: 587-90 (Sept. 15, 1969). (In French).

It was shown that the variations in the parameters a and c of the solid solution from the insertion of oxygen into the hexagonal phase of zirconium are not linear as a function of the oxygen content for the region of existence of the solution. Furthermore, the ratio c/a shows a definite peculiarity in the neighborhood of the composition Zr_8O. (tr-auth)

3037 PHASE EQUILIBRIA IN THE SYSTEMS NEPTUNIUM OXIDE–RARE EARTH OXIDES (Ho, Er, Tm, Yb, Lu). Keller, C.; Engerer, H.; Leitner, L.; Sriyotha, U.; Berndt, U. (Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 31: 3421-6(Nov. 1969). (In German).

The systems neptunium oxide–oxides of the rare earths (RE = Ho, Er, Tm, Yb, Lu) investigated between 1250°C and 1550°C at $p(O_2)$ = 1 atm showed three one-phase and two-phase regions. In the neptunium-rich part a solid solution region with fluorite structure was found which increased slowly with rising temperature. The 1:1 reaction products $(Np_{0.5}, RE_{0.5})O_2$ showed less thermal stability than the analogous double oxides with uranium. The rhombohedral region was identical in all systems with the 1:6 compound $NpO_2 \cdot 6REO_{1.5}$, and no rhombohedral phase range was observed. The maximum solubility of neptunium oxide in the rare earth oxides was 2 mole% and, similarly, increased slowly with temperature. In all mixed oxides investigated neptunium was oxidized more or less to oxidation states higher than four, independent of the various phase regions. (auth) (UK)

3038 THE SYSTEM TUNGSTEN–RHENIUM–SILICON. Skolozdra, R. V.; Popova, N. M.; Fedorov, T. F.; Gladyshevskii, E. I. (Lvov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 66-9(Sept. 1969). (In Russian).

The system W–Re–Si is investigated by means of x-ray and microscopic analysis. The phase equilibria were established at 800°C. The ternary compound W_3ReSi_4 with unknown structure was found. The solubility of W in ReSi is 32 at. %, in Re_5Si_3 it is less than 5 at. %, the solubility of Re in W_5Si_3 is 21 at. %; that of Si in σ- and χ-phases is less than 10 and 5 at. %, respectively. (auth)

3039 SINGLE-CRYSTAL DATA FOR β Ta_2O_5 AND A KPO_3. Wolten, G. M.; Chase, A. B. (Aerospace Corp. Labs., El Segundo, Calif.). Z. Kristallogr., 129: 365-8(Aug. 1969).

Single crystals of one form of β Ta_2O_5 and of the A form of KPO_3 have been grown. The unit-cell dimensions have been determined, and x-ray and morphological data in combination allowed a unique space-group assignment for both: Pna 2 for β Ta_2O_5 and $R\bar{3}$ for A KPO_3. (auth)

3040 SOLUBILITY OF KUO_3 IN $BaUO_3$. Fujino, Takeo; Naito, Keiji (Japan Atomic Energy Research Inst., Ibaraki). J. Amer. Ceram. Soc., 52: 574-7(Nov. 21, 1969).

The formation of a solid solution between cubic perovskite-type KUO_3 and pseudocubic $BaUO_3$ was investigated. The reaction begins at 550°C, and the solubility of KUO_3 reaches more than 30 mole % KUO_3 in $BaUO_3$ at 750°C. The region in which a single-phase solid solution exists was determined. The variation of the lattice parameter of the reacted samples was caused by solid solution formation and by oxygen absorption. The electrical conductivities of the samples varied with composition and showed a distinct maximum. The activation energy for electric conduction was very low compared with that for UO_{2+x} or U_3O_8. (auth)

3041 BEHAVIOR OF URANIA–RARE-EARTH OXIDES AT HIGH TEMPERATURES. Beals, R. J.; Handwerk, J. H.; Wrona, B. J. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 52: 578-81(Nov. 21, 1969).

Uranium dioxide becomes hypostoichiometric when heated above 1600°C in vacuum or in a reducing atmosphere. Upon cooling, free metallic uranium is rejected. The role and the effect of rare-earth oxide additives on the stabilization of urania at high temperatures in a hydrogen environment are evaluated. A tentative phase diagram for the system urania-gadolinia is proposed. (auth)

3042 STUDY OF THE SYSTEMS Sm_2O_3–Nb_2O_5, Gd_2O_3–Nb_2O_5, Dy_2O_3–Nb_2O_5, AND Yb_2O_3–Nb_2O_5 IN REGIONS RICH IN NIOBIUM PENTOXIDE. Godina, N. A.; Savchenko, E. P.; Keler, E. K. Zh. Neorg. Khim., 14: 2214-18(Aug. 1969). (In Russian).

The systems Sm_2O_3–Nb_2O_5, Gd_2O_3–Nb_2O_5, Dy_2O_3–Nb_2O_5, and Yb_2O_3–Nb_2O_5 were studied at 600 to 1300°C in regions rich in Nb_2O_5. The formation of only orthoniobates was established, in contrast to analogous systems with La, Ce, Pr, and Nd, where metaniobates and $Ln_2Nb_{12}O_{33}$ compounds were discovered. The presence of three polymeric forms of Nb_2O_5 was confirmed. (tr-auth)

3043 PHASE DIAGRAM OF THE SYSTEM Cd–Ge–As. Borshchevskii, A. S.; Roenkov, N. D. Zh. Neorg. Khim., 14: 2253-8(Aug. 1969). (In Russian).

On the basis of differential thermal analysis data, microscopic investigations, measurements of microhardness, x-ray structure, and microprobe analyses, six sections of the condensed phase diagram for the Cd–Ge–As system were constructed. The causes of the appearance of extraneous impurities in a series of compounds in the system are discussed. (tr-auth)

3044 CRYSTAL STRUCTURES OF CUBIC AND TRIGONAL YTTRIUM HYPOCARBIDES: A DIMORPHICALLY INTERPHASED SINGLE-CRYSTAL STUDY. Atoji, Masao; Kikuchi, M. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 3863-72(Nov. 1, 1969).

X-ray structure determinations on the cubic YC_x ($x \approx 0.3 - 0.7$, stable above about 900°C) and the trigonal Y_2C (stable below 900°C) were carried out using a quenched "single crystal" in which a transient state in the midst of the cubic-to-trigonal transition has been arrested. The "single crystal" is composed of one cubic and four trigonal single crystals, the trigonal c axis being parallel to one of four cubic body-diagonal axes. The cubic structure is of NaCl type with random holes in the carbon-atom sites and with a = 5.115 ± (2) Å for $YC_{0.44}$. The ordering of the carbon atoms creates the anti-$CdCl_2$-type trigonal Y_2C with the yttrium positional parameter z = 0.2585 ± (3) in the hexagonal-based unit cell, a = 3.617 ± (2) and c = 17.96 ± (1) Å, containing three Y_2C formula units. Mo Kα x-rays were employed, and consequently the disper-

sion corrections on the atomic scattering factor of Y amount to 10%–20% of the nondispersion value and are considerably larger than the carbon-scattering factor. The structure analyses with and without the dispersion corrections demonstrate that even these unusually large corrections do not modulate the Y and C positional parameters significantly. The x-ray single-crystal results were further substantiated by the neutron-powder analysis. The present work confirmed unambiguously not only the reported x-ray powder results as well as the neutron-powder data of the isostructural Ho_2C, but also yielded the structural parameters with a much higher accuracy, hence providing detailed insights into the chemical-bonding correlation in the order–disorder transition. (auth)

3045 APPLICATION OF INERT RADIOACTIVE GASES IN THE STUDY OF SOLIDS. PART I. CLASSICAL EMANATION METHOD AND SURFACE LABELLING METHOD, APPARATUS, AND COMPARISON OF METHODS IN THE STUDY OF FERRIC OXIDE AND THORIUM OXALATE. Balek, V. (Charles Univ., Prague). J. Mater. Sci., 4: 919–27(Oct. 1969).

Two methods based on the release of radioactive inert gases were used to study processes taking place on the heating of solids: the classical emanation method and the surface labelling method. The results obtained with the use of these methods are compared for the study of (a) substances which do not change chemically when heated in the temperature range studied (e.g., $\alpha-Fe_2O_3$), (b) substances in which dehydration and thermal decomposition takes place (e.g., $Th(C_2O_4)_2 \cdot 6H_2O$). For substances which exhibit chemical and structural changes when heated results of investigation by the two above mentioned radiochemical methods are compared with DTA and dilatometric data, obtained under identical experimental conditions. Apparatus permitting simultaneous measurement of the release of two radioactive gases, DTA and dilatometric charges is described. For the substances which do not change when being heated, values of the activation energy of diffusion of inert gases incorporated by different ways are discussed. The advantages of the emanation and surface labelling methods over other physicochemical methods are stated. (auth) (UK)

Radiation Effects

Refer also to abstracts 2231, 2978, 3998, 4026, 4161, and 4176.

3046 (CEA-CONF–1356) ELECTRONIC PROPERTIES OF CARBON IRRADIATED WITH NEUTRONS. Rappeneau, J.; Micaud, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Pacault, A.; Marchand, A.; Amiell, J. (Domaine Universitaire, Talence (France). Centre de Recherches Paul Pascal). [1969]. 20p. (In French). (CONF-690627–2). Dep. CFSTI (U. S. Sales Only).

From 9th Conference on Carbon, Boston, Mass.

Two nuclear graphites, a well-oriented graphite PGCCL and a pyrocarbon deposited at 2100°C, were irradiated with neutrons at 35°C. The electronic properties, and magnetic and paramagnetic susceptibilities, Hall Effect, magnetoresistance, and electrical resistivity were measured at room temperature as a function of the dose. The results showed that damage was less severe in a well ordered structure. (auth)

3047 (KFK–979) COMPATIBILITY INVESTIGATIONS WITH SIMULATED FISSION PRODUCTS ON STAINLESS STEEL AND MOLYBDENUM, WITH AND WITHOUT THE PRESENCE OF UO_2. Hofmann, P.; Thuemmler, F.; Wedemeyer, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). May 1969. 88p. (In German). (EUR-3967). Dep. CFSTI (U. S. Sales Only).

Annealing conditions under which simulated metallic fission products affect the compatibility of UO_2 with stainless steel and molybdenum were investigated. Powder mixtures of UO_2 were used with Mo, stainless steel V2A corresponding to Type 321 SS, V4A corresponding to Type 316L SS and incorporating simulated fission products such as Cs_2CO_3, SrO, CeO_2, ZrO_2, Mo, Pd. Similar studies were conducted on stainless steel in respect of alkali compounds and alkaline earth compounds in the absence of UO_2. When cesium carbonate was present in the powder mixtures vigorous reactions between this compound and stainless steel took place at 750°C and cesium chromates were formed. Strontium and cesium uranates were the principal products formed at 750°C. A reaction took place between CeO_2 and chromium and between CeO_2 and UO_2 with mixed crystals being formed by CeO_2 and UO_2. When several fission-product oxides were simultaneously contained in the powder mixtures the majority of reactions observed took place between these oxides. The predominant reaction products were $SrZrO_3$ (1000°C/5 hr), $Ce_2O_3 \cdot 2\ ZrO_2$ (1000°C/5 hr), $(Zr, Ce)O_2$ (1250°C/5 hr), $SrCeO_3$ (1250°C/5 hr), and Cs_2MoO_4 (750°C/5 hr). Other reaction products were present which could not be identified. (auth)

3048 (ORNL–4470, pp 94–111) FUEL ELEMENT FABRICATION DEVELOPMENT. Adamson, G. M. Jr.; Martin, W. R. (Oak Ridge National Lab., Tenn.).

Irradiation testing of UAl_x and burned U_3O_8 powders as dispersion fuels was extended to higher loadings and burnups. No evidence of potential failure was noted at conditions proposed for advanced HFIR cores. Significantly less swelling was noted for the burned U_3O_8 fuels than for high-fired U_3O_8 or UAl_x. The amount of swelling may be predicted from the initial void volume in the plates and the burnup. A second irradiated HFIR fuel element was examined in the hot cells. It was in better condition than the first one, with no significant dimensional changes or metallographic evidence of incipient failure. The oxide deposit was much more uniform and was thinner. Formation of the dogbone shape during rolling of fuel plates was shown by the use of high-speed motion pictures. During much of the rolling, voids are present at both ends of the core. Techniques for reduction of the amount of dogboning are proposed. The volume of fabrication voids in such plates depended on both the type and concentration of the U_3O_8. Conditions reducing dogboning also reduce the void volume. Sol-gel U_3O_8 offers excellent possibilities for increasing the void volume. The fit between the fuel cores and the frames before rolling was not as critical as previously expected. Miniature fuel plates electrolessly coated with nickel-phosphorus alloy have been placed within the reactor. On samples, the coating resisted spalling from thermal shock and treatment at 300°C but spalled completely after being held at 500°C. Anodic films were developed that protected pure aluminum against corrosion in static tests but not aluminum alloys under dynamic conditions with high heat fluxes. Suitable electron-beam welds were made with either type 6061 or 2219 aluminum in HFIR joint geometries. While adequate penetration was achieved, the strengths are lower than desired. Explosive welding techniques were developed for attaching spacers to HFIR fuel plates. While only intermittent bonds have been achieved in the preliminary tests, the technique appears to be adaptable but expensive. For applications below about 200°C, the tensile strength of dispersion-strengthened aluminum can be enhanced by dissolving magnesium. The room and high-temperature strengths and ductility of $Al-Al_2O_3$ dispersions can be improved by use of atomized alloy powders containing Fe, Mo, Zr, Ti, and Cr. (auth)

3049 (WAPD-TM–805) RELEASE OF FISSION GASES FROM OXIDE FUELS (LWBR DEVELOPMENT PROGRAM). Warner, H. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1969. Contract AT-11-1-GEN-14. 21p. Dep. CFSTI.

A quantitative analysis of the movement of fission-gas bubbles in solids by the mechanism of surface diffusion under a thermal gradient is presented. Interactions of the bubbles with dislocations and grain boundaries are invoked to develop a comprehensive scheme of fission-gas release in oxide fuel rods. A quantitative treatment which is in good accord with the limited experimental data which are available from carefully-controlled irradiation experiments is included. (auth)

3050 CALCULATION PROGRAM MIVOID FOR STRUCTURE CHANGE OF OXIDE FUEL DURING IRRADIATION. Kaneko, Hiromitsu (Power Reactor and Nuclear Fuel Development Corp., Ibaraki, Japan); Hayashi, Hiroshi; Yokouchi, Youji; Matsumoto, Kenichi. J. Nucl. Sci. Technol. (Tokyo), 6: 601–3(Oct. 1969).

Program MIVOID for use in evaluating the processes involved in radioinduced formation of central voids and columnar grains in oxide fuels during early stages of irradiation is described. Program theory is discussed and calculated values are compared with measurements on irradiated fuel. (J.R.D.)

Plastics and Other Materials

Refer also to abstracts 2216, 2217, 2223, 2354, 2417, 4050, 4051, and 4081.

3051 (GAMD–9074) MECHANICAL PROPERTIES OF FIBROUS INSULATION MATERIALS CONSIDERED FOR THE THERMAL BARRIER FOR A PRESTRESSED CONCRETE REACTOR VESSEL. Jones, G. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 1, 1969. Contract AT(04-3)-633. 42p. Dep. CFSTI.

Considering the handling properties of the material and the necessity for a good seal between the insulation and the prestressed concrete reactor vessel (PCRV) liner wall, directly applied kaowool compressed to 12 lb/ft^3 was found to be the best material for the Class A thermal barrier. Tests were performed on

kaowool, microquartz, refrazil, and siltemp. The concept assumes that kaowool will retain its resilience during the 30-year life of the reactor. Conditions most likely to cause the kaowool to lose resilience were investigated and include tests of creep at high temperature, water immersion, steam exposure, compression cycling, and irradiation exposure. All tests proved successful. (J.C.W.)

3052 (IN–1310, pp 1-30) REACTOR HEALTH PHYSICS. (Idaho Nuclear Corp., Idaho Falls).

Activities of the Health and Safety Section at the MTR are reported. The first involved evaluating possible damage to the walls of the MTR canal due to γ irradiation from used fuel stored in the canal. Concrete test specimens that were immersed in air or in water were compression tested after receiving γ irradiations of 10^{10}, 10^{11}, and 2×10^{11} R during a one to 9 yr period. The results showed that γ irradiation adversely affected the compressive strength of the concrete samples, that circulating water around the samples contributed to the strength loss, and that extrapolation of the data for concrete samples submerged in circulating water indicated a 100% loss of compressive strength after γ exposures of 10^{12} R. Therefore, the MTR and γ facility canal walls should be checked periodically for structural integrity. The second project concerned a method for calculating the activities of stack-discharged airborne waste effluent and the development of a formula for performing these calculations is discussed. Finally, MTR procedures for preparing a ^{233}Pa sample, for decontaminating small hot equipment, and for decontaminating a reactor tank are described. (L.C.L.)

3053 (STI/PUB–209) IMPREGNATED FIBROUS MATERIALS. Panel Proceedings Series. Report of a Study Group, Bangkok, 20–24 November 1967. (International Atomic Energy Agency, Vienna (Austria)). 1968. 386p. (CONF-671142). IAEA $9.50.

Nineteen articles and status reports are included on: history of impregnation techniques with fibrous materials; permeability of wood in relation to its structure and penetrability by fluids; factors affecting the impregnation of bagasse and other Far-Eastern fibrous materials; monomer-polymer chemistry and the impregnation process; radiation engineering in the polymerization of monomers in fibrous materials: accelerators; radiation engineering in the polymerization of monomers in fibrous materials: radioisotopes; impregnation and polymerization methods and systems used in the production of wood–polymer materials; degradation of polymers by uv light; emulsion graft polymerization in wood by means of γ irradiation; wood impregnation with polyethyleneglycol; monomers and monomer mixtures used in impregnation of fibrous materials; comparison of thermal, γ, and electron initiation; status and technology of polymer-containing fibrous materials in the Western Hemisphere; status and technology of polymer-containing fibrous materials in the Eastern Hemisphere; fibrous material resources in Asia and the Far East; production economics of impregnated fibrous materials; potential markets for wood–plastic composites in Japan; wood–plastic composites in the wood-carving industry in the Far East; fibre- and particleboard in Asia and the Far East. (J.C.W.)

3054 NEW SURFACE ANALYSIS OF MATERIALS. Anderson, J. L. Mod. Packag., 42: No. 11, 113-16(Nov. 1969).

The evaporation rate analysis (ERA) is a new method involving the measurement of the rate of evaporation, or desorption of a minute amount of added radioactive high-boiling material which is deposited onto the surface being tested and is then monitored as it evaporates into the atmosphere. In the Meseran system, a metered amount of test solution is deposited on the surface to be examined. The test solution consists of a specific high-boiling compound tagged with carbon-14, dissolved in a massive excess of low-boiling non-radioactive solvent. The low-boiling carrier solvent attenuates the low-energy beta-radiation, producing a relatively low initial-count rate, which rises rapidly to a peak as the solvent evaporates. The method has been used to investigate lubricant levels on tin plate, monitor extraction of coatings and packaging materials by solvents contained in a product, measure degree of radiation or thermal cross-linking in polyolefin materials, determine cure characteristics of thermosetting plastics and adhesives, follow degradation and aging of materials, follow plasticizer migration through and from polymers, and determine cure characteristics of coatings in metal cans. (J.C.W.)

3055 IDENTIFICATION OF NUCLEAR PARTICLES BY MEASUREMENTS OF ETCHING RATES ALONG THEIR TRACKS IN DIELECTRIC SOLIDS. Price, P. B. (General Electric Research and Development Center, Schenectady, N. Y.); Fleischer, R. L.; Peterson, D. D. Proc. Int. Symp. Reactiv. Solids, 6th, Schenectady, N. Y., 1968, 735-41(1969).

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y. See CONF-680833.

Discussions are presented of the discovery that in certain plastics the rate of etching along the track of a nuclear particle increases exponentially with the amount by which the particles ionization exceeds the critical rate. This allows identification of particles having virtually the same atomic and mass numbers because of the large difference of their etched track lengths. (J.R.D.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

3056 QUANTUM STATISTICS OF A CHARGED BOSE GAS IN THE GROUND STATE. Nosal, E. A.; Grandy, W. T. Jr. (Univ. of Wyoming, Laramie). Ann. Phys. (N. Y.), 55: 1-21 (Oct. 15, 1969).

A gas of interacting charged bosons is examined with the temperature-dependent methods of quantum-statistical mechanics, and the ground-state properties are calculated. A somewhat new approach to the boson problem is introduced, which is compared to previous methods utilized in studying this and other problems. The energy of the ground state is found to be in substantial agreement with recent calculations employing different techniques, and a very recent discovery concerning the correct expansion for the depletion of the ground state is confirmed. Several other thermodynamic quantities are also discussed and calculated. (auth)

3057 NEKOTORYE PROBLEMY TEORII ZVEZDNYKH ATMOSFER. (Some Problems in the Theory of Stellar Atmospheres). Tartu, Academy of Sciences, Estonian SSR, Tartu Astrophysical Observatory, 1968. 111p.

Eight papers are included on the following: (1) approximate theory of model stellar atmospheres, (2) determination of temperature and pressure distributions in the extended stellar atmospheres, (3) temperature-correcting method in a stellar atmosphere, (4) approximate analytical pressure-temperature dependence in a stellar atmosphere, (5) convection in stellar atmospheres, (6) scattering processes in the equation of radiative transfer, (7) radiative transfer in a spherical atmosphere of free electrons; scattering by unmoving electrons, and (8) radiative transfer in a spherical atmosphere of free electrons; scattering by electrons in thermal motion. (M.O.W.)

Cosmic Ray Exposure Ages

3058 LUNAR AND METEORITE RADIOACTIVITY. Lavrukhina, A. K.; Ustinova, G. K.; Ibraev, T. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1799-1801(Nov. 1968). (In Russian).

The distribution of nuclear-active particles in bodies of various size was studied. Calculations of the rate of distribution of cosmogenic ^{40}K in iron meteorites and metallic-phase chondrites showed that the content of ^{40}K in metallic chondrites is higher than in iron meteorites. Moreover, the difference increased with the increase of meteorite radius. For example, in the center of a meteorite of radius 30 cm, the content of ^{40}K was 61% of the surface value and in a chondrite it was almost 92%. In the meteorites the primary particles play the main role in formation of ^{40}K. The secondary particles followed the sequence of fast neutrons > shower particles > fast protons > fast mesons. The lunar surface proved to be an ideal object for studying cosmic radiation. The correlation of curves constructed for ^{40}K distribution in meteorites could be used for forming an hypothesis of meteorite formation by asteroid collisions and checking the hypothesis of meteorites from the lunar surface. (R.V.J.)

Stars

Refer also to abstracts 3328, 3605, 3606, 3763, and 3765.

3059 MODEL ATMOSPHERES OF THE EARLY SPECTRAL TYPE STARS. PART II. Rucinski, Slawomir. Postepy Astron., 17: 201-16(1969). (In Polish).

The contemporary methods of constructing the nongray model atmospheres of early-type stars without assuming local thermodynamic equilibrium (non-LTE models) is described. Feautrier's method for the numerical solution of the transfer equation in case of a complicated source function (for example with the noncoherent scattering included) is given. (auth)

3060 DIFFERENTIALLY ROTATING HAMADA-SALPETER WHITE DWARF MODELS. Gribbin, J. R. (Cambridge Univ., Eng.). Astrophys. Lett., 4: 77-9(Sept. 1969).

Pulsation periods are determined for degenerate, differentially rotating white dwarfs obeying the Hamada–Salpeter equation of state. Periods below 0.2 sec are obtained with moderate amounts of rotation, and no unstable models are found. (auth)

3061 TERM ANALYSIS OF Fe IV AND IDENTIFICATION OF [Fe IV] IN RR TELESCOPII. Edlen, Bengt Mon. Notic. Roy. Astron. Soc., 144: 391-6(1969).

From an experimental investigation of the fourth spectrum of iron the levels of $3d^4(^5D)4s$ and $3d^4(^5D)4p$, as well as the set of $3d^5$ levels, are reported. This set permits a practically exhaustive prediction of the spectrum of forbidden Fe IV lines to be made and explains the origin of 17 emission lines in RR Telescopii. (auth) (UK)

3062 THE MAIN-SEQUENCE GAP AND RED-GIANT CLUMP OF NGC 6939. Cannon, R. D.; Lloyd, C. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 449-58(1969).

The results of new photographic photometry are given for the open cluster NGC 6939, and using earlier proper motion measurements a color–magnitude diagram is obtained for those stars believed to be cluster members. The cluster appears to have an age of about 10^9 years, and has a low density region on the main sequence in agreement with a theoretically predicted gap. The red giant branch shows one very marked concentration which is tentatively identified with the horizontal branch found in globular clusters. There are a few anomalous bright blue stars, similar to those in other old clusters, well above the main sequence turnoff. (auth) (UK)

3063 MINIMAL AND MAXIMAL VALUES OF THE CENTRAL PRESSURE AND TEMPERATURE IN CONVECTIVELY STABLE STARS. Kovetz, A. (Tel-Aviv Univ., Ramat-Aviv, Israel). Mon. Notic. Roy. Astron. Soc., 144: 459-60(1969).

For the convective stability of a star it is necessary that the specific entropy should not decrease outwards. Subject to this condition the minimal value of the central pressure in a star of mass M and radius R, and the maximal values of the central pressure and temperature in a star of mass M and central density ρ_c, are obtained when the configurations are isentropic. (auth) (UK)

3064 CEPHEID PULSATION. I. NUMERICAL TECHNIQUE AND TEST CALCULATIONS. Stobie, R. S. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 461-84(1969).

The numerical technique developed to compute the nonlinear, radial pulsation of a spherical star is described. The models constructed consist of a radiative envelope down to a temperature of 10^6K corresponding in radius to the outer four-fifths of the star. The only ionization zones considered as contributing substantially to the excitation are those of hydrogen and helium. Results of test calculations are reported to illustrate the sensitivity of the full amplitude motion to the free parameters in the construction of a model. (auth) (UK)

3065 CEPHEID PULSATION. II. MODELS FITTED TO EVOLUTIONARY TRACKS. Stobie, R. S. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 485-510(1969).

The results of a survey of classical Cepheids are presented. The masses and luminosities of the models in the survey were chosen to correspond to where the evolutionary tracks of 5 to 9 $M_\odot$ stars cross the Cepheid strip. The effect of helium content on the position of the high T_e boundary of the instability strip is examined and it is found that for every 15% increase in helium (by mass) the strip shifts by ~600°K to higher T_e. Three different modes of pulsation are investigated for instability—fundamental, first, and second modes. The existence of second mode instability is confirmed for three stars all of which have a period less than two days. The presence of secondary "bumps" in the light and velocity curves was a prominent feature of many of the models. However, in no case did the "bump" occur (for a given period) at the phase expected from a comparison with observation. The only way in which the phase of the "bump" can be brought into agreement with observation is for the mass, at a given luminosity, to be reduced by a factor ~2 compared to the evolutionary calculations. (auth) (UK)

3066 CEPHEID PULSATION. III. MODELS FITTED TO A NEW MASS–LUMINOSITY RELATION. Stobie, R. S. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 511-35(1969).

A new mass–luminosity relation for classical Cepheids was chosen so that models, which exhibited a prominent secondary "bump" in the light and velocity curves, agreed well with the observed period-phase of "bump" relation. The high T_e edge of the instability strip is sensitive to the helium content, and comparison with observation gives a helium content of 45% by mass, though it must be emphasized that this value depends critically on the assumed $(B - V) - T$ relation. The models, which were

examined in the fundamental, first, and second modes, covered a period range of 1 to 40 days. Due to the narrowness of the observed strip, a satisfactory guide as to which mode a star is pulsating in can be obtained simply from the period. In general, Cepheids of period greater than 7 days pulsate in the fundamental, those of period between 2 and 7 days pulsate in the first mode, and those of period less than two days pulsate in the second mode. In every case where a model exhibited a prominent secondary "bump" it was found to be pulsating in the fundamental mode. No satisfactory period–luminosity relation was found because of the finite width of the strip. However, the existence of a period–radius–mass relation automatically implies the existence of a period–luminosity–color relation provided that classical Cepheids obey some mass–luminosity relation. This period–luminosity–color relation was derived separately for the fundamental mode pulsators and the first-mode pulsators. (auth) (UK)

3067 EFFECT OF ROTATION ON PULSATION PERIODS OF DEGENERATE WHITE-DWARF MODELS. Gribbin, John R. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 549-52(1969).

It is shown that for models of degenerate stars the fundamental pulsation periods in the presence of solid-body rotation can be found to high accuracy (error <2%) without solving the pulsation equation for a rotating body. The appropriate periods are given for models obeying both the Hamada–Salpeter and Chandrasekhar equations of state. (auth) (UK)

3068 PULSAR PERIODS AND RAPID CHANGES IN THE TERRESTRIAL ROTATION RATE. Maran, S. P.; Ogelman, H. (Goddard Space Flight Centre, Greenbelt, Md.). Nature (London), 224: 349(Oct. 25, 1969).

It is stated that random fluctuations in the rotation rate of the Earth are occasionally large enough to affect significantly measured values of $\Delta P/P$ for pulsars (P is pulse repetition period). A high precision has been attained in measurements of $\Delta P/P$, but it is emphasized that it is necessary to analyze the data carefully in order to exclude effects due to the random variations in length of the day, which may amount to fluctuations as large as 0.5 ms with time scales of the order of a month. The question is examined as to whether such an effect can be detected in pulsar observations. The effect can be minimized by taking measurements at small hour angles, or symmetrically about the meridian. Conversely, closely spaced observations of several pulsars can be used to study the random variations of the terrestrial rotation rate, for which a definitive explanation is not yet available. The high precision obtainable in pulsar timings also requires that careful attention be paid to the exact position of the telescope with regard to the terrestrial axis of rotation. (UK)

3069 A NOTE ON BINARY SYSTEMS WITH UNDERSIZE SUBGIANT SECONDARIES. Field, J. V. (Queen Mary Coll., London). Mon. Notic. Roy. Astron. Soc., 144: 419-23(1969).

The observational data for the eighteen binary systems listed by Kopal (1958) as having "undersized subgiant secondaries" are analyzed to determine whether it is possible that these systems are in pre-main sequence contraction. It is found that only four of them could be in this phase. (auth) (UK)

3070 DQ HERCULIS: SYNCHRONOUS PHOTOMETRY. Nather, R. Edward; Warner, Brian (Univ. of Texas, Fort Davis. Univ. of Texas, Austin). Science, 166: 876-7(Nov. 14, 1969).

Synchronous signal averaging, applied to the photometry of the stellar system DQ Herculis in order to study the 71.1-second pulsations discovered by Walker in 1956, yields a light curve which is a pure sinusoid, within the accuracy of measurement. The binary period is increasing, probably as a result of mass lost from the system. (auth)

3071 CONCERNING THE ORIGIN OF SUPERHEAVY ELEMENTS. Berlovich, E. E.; Novikov, Yu. N. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 9: 445-8(June 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pisma Redaktsiyu, 9: 708-12(June 20, 1969).

Recently, Fowler's group observed in the cosmic-ray spectrum nuclei with charge $Z \simeq 108 \pm 2$. According to ideas prevailing to date, such heavy elements cannot result from the r process occurring in supernovae. The reason is that the r process is terminated as a result of neutron-induced fission, which occurs, according to the latest estimates of Hoyle and Fowler, at mass numbers $A \simeq 270$ to 275 ($Z \simeq 93$). These estimates are questioned and new values are derived for the r-process termination. (W.D.M.)

3072 SCALE OF ABSOLUTE MAGNITUDE OF THE O STARS. Divan, Lucienne; Burnichon, Marie-Louise (CNRS, Paris). Compt. Rend., Ser. B, 269: 235-6(July 28, 1969). (In French).

The problem raised by the depth of 1000 pc found for small-mass O stars, assumed cylindrical (less than 10 pc in diameter) located in IC 1805, is examined. This improbable depth is attributed to the uncertainty which prevails concerning the absolute magnitudes of O stars, and it is shown that the difficulty can vanish if a second parameter (the parameter λ_1) is introduced in the calculation of these absolute magnitudes. (tr-auth)

3073 INTENSITY VARIATION OF THE PASCHEN LINES OF HYDROGEN AS A FUNCTION OF SPECTRAL TYPE AND CLASS OF LUMINOSITY. Andrillat, Yvette; Baylac, Marie-Odile (Observatoire de Haute-Provence, Basses-Alpes, France. Faculte des Sciences, Herault, France. Observatoire, Meudon, France). Compt. Rend., Ser. B, 268: 1537-40(June 9, 1969). (In French).

From the 230 Å/mm dispersion spectra obtained from a 120-cm telescope, the intensity variations of hydrogen lines of the Paschen series were studied. Microphotometric recordings beyond 7700 Å/mm of the spectra of two stars of very similar type: η Leo AO Ib and 4 Lac B 9 Iab, are shown and analyzed. Also, the P 14 central intensity for about forty brilliant stars was measured. Curves showing the variation of the central intensity as a function of the color index are presented. These observational results were compared with theoretical calculations, and good agreement was obtained. (J.F.P.)

Quasi-Stellar, Radio, and X-Ray Sources

3074 SOME VERY COLD H I CLOUDS FOUND IN EMISSION. Verschuur, G. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett., 4: 85-7(Sept. 1969).

Several very narrow neutral hydrogen emission lines were found in the spectra of low- and intermediate-velocity neutral hydrogen clouds. At least two clouds must have kinetic temperatures of ≤30°K. (auth)

3075 OCCULTATION POSITIONS OF THE 1665-MHz OH EMISSION FROM G 0.7–0.0. Manchester, R. N.; Goss, W. M.; Robinson, B. J. (Commonwealth Scientific and Industrial Research Organization, Sidney). Astrophys. Lett., 4: 93-8(Sept. 1969).

Lunar occultation measurements have given positions for five separate features of the circularly polarized 1665-MHz OH emission from G 0.7–0.0 (Sgr B2). The most intense left-hand and right-hand features appear to be separated by about 2 arc sec, while weaker features are displaced by up to 20 arc sec. For the stronger features the probable error in position is ±2 arc sec in declination and ±0.05s in right ascension. (auth)

3076 DYNAMIC SPECTRA OF PULSARS IN THE FREQUENCY RANGE 110 TO 420 MHz. Huguenin, G. R. (Univ. of Massachusetts, Amherst); Taylor, J. H.; Jura, M. Astrophys. Lett., 4: 71-5(Sept. 1969).

Observations of the dynamic spectra of 10 pulsars were made in the range 110 to 420 MNz. Narrow-band emission features were observed for 8 of them. The widths of the emission bands scale approximately as frequency to the power 2.8, and not to the power ≥4 as predicted by existing scintillation theories. (auth)

3077 CLUSTERS OF QUASI-STELLAR OBJECTS. Bell, M. B. (National Research Council, Ottawa). Nature (London), 224: 229-34(Oct. 18, 1969).

It is stated that an analysis of 150 QSO redshifts suggests that there are groupings of QSO's extending over large areas of the sky. The inference is that QSO's are not at cosmological distances. (UK)

3078 SYNCHROTRON MODEL FOR PULSARS. Takakura, T. (Tokyo Univ.). Nature (London), 224: 252-3(Oct. 18, 1969).

Measurements of the elliptic polarization of pulsar CP 0328 at 610 and 240 MHz show a clear variation of this polarization during each pulse, the polarization changing from right to left handed ellipses through a stage of linear polarization near the peak intensity of each pulse. These characteristics are typical of synchrotron emission from a well-collimated beam of electrons if the rotation model is adopted for the pulsar. It may be expected that the duration of each pulse from a pulsar depends on the frequency if the synchrotron and rotation model is correct, so that the duration is longer at lower frequencies. It would be desirable to measure the pulse shape and polarization at two distant frequencies in order to test the synchrotron model, and tests should be made on pulsars whose elliptic polarization changes strongly during the pulse, since there may be pulsars whose pulse is a superfriction of unresolved shorter pulses from several sources, so that both the change in elliptic polarization and the

frequency dependence of the duration of the pulse may not be clear. Amplification of synchrotron radiation is also discussed in regard to stimulated emission. The possibility of wave amplification is of great advantage for the synchrotron model, to account for the extremely high brightness temperature required for the small emission source. (UK)

3079 X-RAY LINE EMISSION FROM SCO X-1. Angel, J. R. P. (Columbia Univ., New York). Nature (London), 224: 160-1(Oct. 11, 1969).

A Monte Carlo technique was used to obtain an estimate of the spectral distribution of scattered line radiation from Sco X-1, using a simple spherical model with uniform density and having optical depth 12. It was supposed that photons of energy E_0 are generated uniformly throughout the sphere, and that these are scattered with Thomson theory angular distribution and without absorption. A Maxwellian electron velocity distribution corresponding to a temperature of 5×10^7 K was assumed and the new energy E′ after each scattering was calculated. It was calculated that only 6% of the energy emitted in a given line emerges without any scattering, the remainder being scattered into a broad continium, which however would be virtually impossible to detect in the presence of the much stronger bremsstrahlung continuum. The unscattered radiation should be detectable if an instrument of sufficiently high resolution were available. (UK)

3080 NATURE OF PULSARS. Vila, S. C. (Inst. for Space Studies, New York). Nature (London), 224: 157-9(Oct. 11, 1969).

It is stated that the magnitude and the scattering of pulsar periods, which range from 0.033 to 3.7 sec., make it improbable that these are pulsation periods, and it is usual to associate them with periods of rotation. The discovery of a second periodic pulsation in AP 2015 + 28 and CP 1919, and its probable existence in CP 0950 and 1133, suggest that the existence of two pulsation periods may be common to all pulsars. The present author considers this second period to be a period of rotation, based on consideration of the most general motion of a symmetrical body free of external forces or torques, which is a motion of rotation and precession of the rotation axis on a circular cone the orientation of which is fixed in space. It is further assumed that the mechanism producing the radiation causes emission only in a cone of narrow angle; this is the case for synchrotron radiation from a collimated electron beam that corotates with the star close to the equatorial plane, following the motion of a magnetosphere rigidly attached to the star. A detailed analysis of these considerations is given. (UK)

3081 SCATTERING OF PULSAR X-RAY RADIATION BY INTERSTELLAR DUST PARTICLES. Slysh, V. I. (Inst. for Space Research, Moscow). Nature (London), 224: 159-60(Oct. 11, 1969).

It is shown that interstellar dust particles may strongly affect the pulsed x radiation from the Crab Nebula pulsar NP 0532. A solid particle of radius 0.5 μ at $\lambda = 5$ Å scatters nearly all the incident radiation into a beam about 2′ wide, resulting in a halo around the pulsar of half this size. True absorption in such a particle appears to be small. For NP 0532 only a few per cent of the x-ray flux near $\lambda = 5$ Å will be pulsed, while the remaining flux will be scattered into a halo about 1′ wide with time delays of up to half an hour, thus completely smearing the pulses. This is also essentially the structure observed in the x-ray source Tau XR-1. The extended source of angular size about 1′ to 2′ usually attributed to the Crab Nebula may, in fact, be the halo of NP 0532, while the pulsed component containing about 5% of the total flux at 3 to 15 Å could be that part of the x-ray pulsar flux which escaped scattering by interstellar dust. This means that the x-ray flux emitted by the pulsar is equal to the total flux from Tau XR-1, so that the contribution from the Crab Nebula is negligible compared with the pulsar flux. This might completely change the spectrum of NP 0532, and also reduce the difficulties associated with the lifetime of the relativistic electrons required to explain synchrotron emission from the Crab Nebula. The effect depends strongly on the nature, and particularly the size, of interstellar dust particles. The proposed origin of the extended x-ray source in Taurus leads to several predictions of halo features which might be detected by special observations. Such measurements might also supply new information about interstellar dust particles. Nonexistence of the predicted halo would mean that the size of the particles is much smaller than assumed. (UK)

3082 MAGNETIC FIELD DECAY IN A NEUTRON STAR AND DISTRIBUTION OF PULSAR PERIODS. Pacini, F. (Astrophysical Lab., Rome). Nature (London), 224: 160(Oct. 11, 1969).

It is stated that two basic conditions appear to be required to produce a pulsar and an output of relativistic particles in the surroundings of a neutron star, namely stellar rotation and strong magnetic fields ($H = 10^{10}$ to 10^{13} G). Both the axisymmetric case and the oblique rotator model predict a slowing down of the period P inversely proportional to P; this implies a release of rotational energy proportional to P^{-4}. The distribution of periods, however, shows a remarkable cutoff towards the longer periods. This cutoff cannot be due to selection effects, and is not easily understood even if the release of rotational energy is proportional to P^{-4}. A likely explanation of the distribution of periods lies in the time decay of the stellar magnetic field. The expected lifetime of the magnetic field in a neutron star is relatively short because the increase is electric conductivity does not compensate the decrease in radius, and for a standard neutron star the decay time would be about 3×10^6 yr. This appears to be consistent with the distribution of periods if $P \alpha P^{-1}$. The maximum period attained by a pulsar during the lifetime of the field may be proportional to the surface magnetic strength and to the square root of the electrical conductivity. The maximum observed period (P = 3.75 sec) corresponds to about 10^{13} G, and this value is just below the maximum field strength which can be treated in the framework of the classical electromagnetic theory. (UK)

3083 OBSERVATIONS OF THE CRAB PULSAR DURING AN OCCULTATION BY THE SOLAR CORONA. Goldstein, S. J.; Meisel, D. D. (Univ. of Virginia, Charlottesville). Nature (London), 224: 349-50(Oct. 25, 1969).

Measurements are reported of the differences in arrival time between individual pulses from NP 0532 in frequency bands at 112, 142, and 170 MHz; the measurements were made with the 300-ft telescope of the National Radio Astronomy Observatory, between June 12 and 23, 1969, when the pulsar had heliocentric angular distances in the range 1.5 to 8.7°. The approximate time delay between the high and middle bands was 3.5 sec and between the high and low bands 10.5 sec. Data are tabulated for 7 days on which strong pulses were received. The absence of signals on two days appears due to the sporadic nature of the source. The strongest pulses were stronger than from any other pulsar observed; one pulse showed a peak flux density $>10^{-23}$ Wm^{-2} Hz^{-1} at 170 MHz. An accurate value of the dispersion leads to the possibility of finding the relative delay between a light pulse and a radio pulse from NP 0532. Determinations of the coronal electron density are discussed, in relation to the observations. (UK)

3084 TEMPORAL AND SPECTRAL VARIATIONS IN THE AMPLITUDES OF THREE PULSARS AT 80 MHz. Slee, O. B. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 223-5(Mar. 1969). (RPP-1248).

The Culgoora radioheliograph was used to investigate the interesting changes which take place in the amplitudes of the pulses from PSR 0950 + 08, 1133 + 16, and 1919 + 21. The experiments had two main objectives: (i) to investigate the temporal changes in the spectrum near 80 MHz; (ii) to search for periodicities in the pulse amplitudes with periods extending up to one or two minutes. (W.D.M.)

3085 TIME VARIATION IN THE POLARIZATION OF OH EMISSION FROM NGC 6334B. Goss, W. M.; Robinson, B. J.; Manchester, R. N. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 214-15(Mar. 1969). (RPP-1257).

Investigations of time variations in NGC 6334B were begun with the Parkes 210-foot antenna in October 1967; these observations were continued in December 1967 and October 1968. A comparison between the first two dates are shown. No clear evidence for variation was found in any of the Stokes parameters for features found to be varying by Ball and Meeks (1968). (W.D.M.)

3086 A WIDEBAND OH EMISSION SOURCE. Manchester, R. N.; Goss, W. M.; Robinson, B. J. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 212-14(Mar. 1969). (RPP-1251).

Observations of galactic H II regions in the longitude range 280 to 300° were made at the OH-line frequencies 1612.231, 1665.402, and 1667.358 MHz using the Parkes telescope. Strong emission was observed at 1612 and 1665 MHz from a source near the regions of Hα emission RCW 48 and RCW 49. The source was named G 284.2 − 0.8. (W.D.M.)

3087 A THERMAL SOURCE WITH STRONG 1612 MHz OH EMISSION. Robinson, B. J.; Goss, W. M.; Manchester, R. N. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 211-12(Mar. 1969). (RPP-1259).

During 1968 several types of emission in lines of the 18-cm quadruplet of the ground-state OH molecule were found at Parkes. This note describes a strong source of 1612-MHz emission near galactic longitude 331°. (W.D.M.)

3088 PULSAR TEST OF A VARIATION OF THE SPEED OF LIGHT WITH FREQUENCY. Feinberg, G. (Columbia Univ., New York). Science, 166: 879-81(Nov. 14, 1969).

The sharply defined optical and radio pulses from pulsars make possible a test of the variation of the speed of light with frequency and of the possible existence of a photon mass. The data indicate that the mass of a real photon is less than 10^{-44} gram. Detection of extragalactic pulsars could allow a substantial improvement of this limit. (auth)

Solar Phenomena

Refer also to abstracts 3203, 3210, and 3244.

3089 (N-69-36291) X-RAY EMISSION FROM THE SOLAR CORONA. Beigman, I. L.; (and others). (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Russian Preprint No. 104. 22p. (NASA-CR-105625). CFSTI.

A number of new experimental data have recently become available on the spectrum of the solar corona in the x-ray region (1 to 30 Å). In this paper, the spectrum is theoretically calculated with a number of refinements compared to previous computations. Specifically, dielectronic recombination and photorecombination on all levels were taken into consideration in calculating the ionization equilibrium. A computer was used for determining the effective cross sections of excitation, ionization, dielectronic recombination and photorecombination necessary for calculating population intensities. (auth) (STAR)

3090 HEATING OF SOLAR CORONA. Kuperus, M. (Astronomical Inst., Utrecht). Space Sci. Rev., 9: 712-39 (Aug. 1969).

A discussion is given of the present state of the theory of the heating of the solar corona by shock waves. Arguments are presented why the main contribution to the mechanical energy flux is of acoustic origin, while estimates for the amount of acoustic energy generated in the convection zone as well as the deviations from isotropy are given. During propagation through the atmosphere acoustic waves develop into shock waves after a distance of a few scale heights in the chromosphere. The heating of the outer layers by dissipation of shock waves is found to be sufficient to account for the observed radiative and corpuscular energy losses. Much emphasis is laid on the competitive role played by the four fundamental processes of energy transfer: mechanical heating, radiation, heat conduction, and convection of energy in establishing the equilibrium structure of the corona. The atmosphere may be divided into several regions according to the predominance of one of the energy processes mentioned above. The physical properties of the chromosphere and the solar wind are discussed only where they are intimately connected with the problem of the heating of the corona. The most important aspects of the influence of a magnetic field on the structure and the heating of the corona in magnetically active regions are briefly mentioned. Special attention is paid to the strong channelling of heat flow along the field lines and its consequences for the structure and dynamics of the chromosphere-corona transition layer. (auth)

3091 OBSERVATION OF THE MAGNETIC STRUCTURE OF A TYPE-IV SOLAR RADIO OUTBURST. Wild, J. P. (CSIRO, Sydney). Solar Phys., 9: 260-4(Oct. 1969).

A continuous record of the 80 MHz image and polarization of a type IV solar outburst was made with the Culgoora radioheliograph from which the magnetic structure of the event can be directly inferred. The first ('moving') part of the event appeared beyond the limb as an expanding magnetic arch along which three concentrated sources developed; one unpolarized source near the peak, attributed to synchrotron radiation; and two polarized sources of opposite polarity near the feet, attributed to plasma radiation. The radio-emitting arch appeared to lie above an eruptive prominence seen in Hα. The second ('stationary') part was seen later as a separate highly polarized source on the disk above the projected position of the flare that had previously triggered the prominence activity. (auth)

3092 PENCIL-BEAM OBSERVATION OF SOLAR BURSTS AT 36 GHz. Felx, G. (Univ., Bochum, Ger.). Solar Phys., 9: 265-8(Oct. 1969).

From a burst survey at 36 GHz, the diameter of the burst core was always found less than 1'. Several limb bursts with a remarkable flash intensity were observed. Comparison of corresponding bursts on the disk exhibit, in general, a recognizable post-increase phase which seems to become faint at the solar limb. (auth)

3093 DE-OCCULTATION X-RAY EVENTS OF DECEMBER 2, 1967. Zirin, Harold (Carnegie Institution of Washington, D. C. California Inst. of Tech, Pasadena); Ingham, William; Hudson, Hugh; McKenzie, David. Solar Phys., 9: 269-77(Oct. 1969).

A flare rising from behind the solar limb was recorded simultaneously by the UCSD x-ray detector on OSO-111 (7.7 to 200 keV) and the Caltech photoheliograph on Robinson Laboratory roof (Hα). The de-occultation gives excellent spatial resolution of the x-ray source. Spectra suggest that the material was already heated to 27,000,000° and that the increase in flux was due to the de-occultation. The flux rise to maximum was proportional to the apparent area. The uniformity of this rise shows that there was no special kernel of emission. Comparison of the deduced volume with the bremsstrahlung formula gives a density of about 10^{10} for the 27,000,000° component of the flare; this is confirmed by consideration of the maximum possible Coulomb braking. The actual decay is more likely by escape rather than Coulomb braking. (auth)

3094 SOLAR CIRCUMSTANCES AT THE TIME OF THE COSMIC-RAY INCREASE ON JANUARY 28, 1967. Dodson, Helen W.; Hedeman, E. Ruth (Univ. of Michigan, Ann Arbor). Solar Phys., 9: 278-95(Oct. 1969).

Solar circumstances have been evaluated for January 28, 1967, the date of an observed ground level enhancement of cosmic rays which was not preceded by observation of a suitably great Hα flare. On the visible solar hemisphere, a bright subflare at S23°E19° occurred in appropriate time association with the cosmic-ray event, and was accompanied by weak x-ray enhancement and radio-frequency emission. If this flare, alone, or in combination with other minor flares observed on the visible hemisphere on January 28 was the source of the energetic cosmic rays recorded on that date, then current thinking regarding the characteristics of cosmic-ray flares must be modified. An initial study of probable circumstances on the invisible hemisphere did not lead to the immediate recognition of a major center of activity as the probable source of a cosmic-ray flare. Further evaluation of all centers of activity on the invisible hemisphere identified one region. McMath Plage No. 8687, 64° beyond the west limb, as the most plausible, possible site for the cosmic-ray flare on January 28, 1967. The location of this region is in accord with the source-position deduced in Lockwood's analysis (1968) of the cosmic-ray event. This center of activity could not have been more than 5 days old on January 28, 1967. The interval of major activity in the region was confined primarily to the invisible hemisphere. The occurrence of an 'isolated' major flare in the region on February 13, 1967 is discussed. The present study exemplifies the partial nature of solar observations which are limited to the visible hemisphere. The possible role of exceptional geomagnetic calm, 1963-1967 in permitting atypical cosmic-ray enhancements, as on January 28, 1967, is mentioned. (auth)

3095 EQUATOR-POLE EFFECT IN THE CENTRAL INTENSITIES OF SOME STRONG SOLAR FRAUNHOFER LINES. Burger, Marijke; Houtgast, J. (Astronomical Inst., Utrecht). Solar Phys., 9: 296-302(Oct. 1969).

Uncorrected central intensities of the Fraunhofer lines NaD_1 and D_2, Mgb_1 and b_2, and Hβ were determined at a number of points along the S-W limb of the sun, from equator to pole, using photographic spectra taken at the Locarno station of the Göttingen Observatory. No significant pole-equator variation could be found in excess of the observational errors which are of the order δI 2%. (auth)

3096 TEMPERATURE FLUCTUATIONS IN THE SOLAR PHOTOSPHERE. II. THE MEAN LIMB-DARKENING AND THE SECOND MAXIMUM. Wilson, P. R. (Univ. of Sydney). Solar Phys., 9: 303-14(Oct. 1969).

In paper I it was shown that Edmonds' center-limb rms intensity fluctuation data provided strong evidence for the existence of a maximum in the horizontal temperature fluctuation near 250 km (optical depth 0.7). The data also gave a much-less-reliable indication of a second temperature fluctuation maximum approximately 100 km below this level. Two models, model 1 exhibiting a single temperature fluctuation maximum and model 2 which has two temperature fluctuation maxima, were put forward as worthy of further investigation. In this paper the theoretical mean limb darkening for these models is compared with the observed limb darkening. Neither is satisfactory and several modifications are discussed. Models of the first type can be made to fit these data only by making adjustments which appear to be inconsistent with convection as an explanation of the temperature fluctuations. Further, the agreement with the fluctuation data is now less satisfactory. However, a modified model of the second type is developed which is consistent with the convection hypothesis which is in good agreement with the mean limb darkening and is in qualitative agreement with the fluctuation data. This is interpreted as providing some evidence that the photospheric granulation arises from a shallow convection layer at the base of the photosphere. (auth)

3097 MORE ON GRANULATION MODELS. Margrave, Thomas E. Jr. (Georgetown Coll. Observatory, Washington, D. C.); Swihart, Thomas L. Solar Phys., 9: 315-16(Oct. 1969).

The authors give rebuttal to Wilson's criticisms (Solar Phys., 8: 20(1969)) of their paper (Solar Phys., 6: 12(1969)). It is concluded that an accurate and completely self-consistent model of the photosphere is extremely difficult to obtain, and it is still a thing of the future. (W.D.M.)

3098 COARSE STRUCTURE OF THE SOLAR ATMOSPHERE. Simon, M.; Zirin, H. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys., 9: 317-27(Oct. 1969).

Observations of the quiet Sun at wavelengths from 3 Å to 75 cm show (with two exceptions: the OVI line at 1032 Å and possibly the continuum at 1.2 mm) either no limb brightening or less than had been supposed. On the other hand, the brightness temperature is observed to increase with wavelength in the millimeter and centimeter range. If this increase is due to greater visibility of hot overlying material, that material ought to be evident at the limb at shorter wavelengths, resulting in limb brightening. The only possible explanation for the absence of limb brightening at almost all wavelengths is that the emitting surface is rough at all wavelengths, with a scale of roughness approximately equal to the scale height at each temperature. Contradictions with existing models, along with the additional observations required for an improved model are discussed. (auth)

3099 SOLAR VELOCITY FIELDS: 5-MIN OSCILLATIONS AND SUPERGRANULATION. Tanenbaum, Andrew S. (Univ. of California, Berkeley); Wilcox, John M.; Frazier, Edward N.; Howard, Robert. Solar Phys., 9: 328-42(Oct. 1969).

One-dimensional magnetograph scans were used to study the 5-min photospheric velocity oscillations and the supergranulation. The oscillations in the wing brightness lead the oscillations in velocity by less than 90° in the photosphere, and about 90° in the chromosphere, suggesting that they are traveling waves at lower levels and standing waves at higher levels. Downward flows were observed to be coincident with the chromospheric network, confirming the hypothesis that material is flowing downward at supergranular boundaries. (auth)

3100 SOME PROPERTIES OF VELOCITY FIELDS IN THE SOLAR PHOTOSPHERE. II. THE SPATIAL DISTRIBUTION OF THE OSCILLATORY FIELD. Deubner, Franz-Ludwig (Fraunhofer Inst., Freiburg i. B.). Solar Phys., 9: 343-6(Oct. 1969).

Observers more or less agree that the photospheric oscillations are irregular in space and time. But the observations this conclusion has been drawn from are mainly spectra or repeated single line scans, i.e., one-dimensional records. Since these observations give only limited information on the two-dimensional structure of the velocity field, several series of two-dimensional photoelectric tachograms were taken with the Capri magnetograph in Fe I 5250 as well as in HÅ. An area of 65″ × 92″ in the center of the Sun was scanned every 450 sec with a scanning spot of 3″ × 3″. (W.D.M.)

3101 EVOLUTION OF THE PHOTOSPHERIC NETWORK. Sheeley, N. R. Jr. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys., 9: 347-57(Oct. 1969).

A time-lapse sequence of spectroheliograms in the bandhead of CN at λ3883 reveals the following behavior of the photospheric network with time: (1) There is a steady flow of bright 'points' (≈1000 km in diameter) laterally outward from sunspots at speeds on the order of 1 km · sec^{-1}. After traveling about 10,000 km from a sunspot they either conglomerate to form fragments of the photospheric network or disappear. (2) Spatial changes in the network pattern seem to take place by means of the shifting of network fragments laterally on the solar surface. Although most small-scale details are recognizable after 5 to 10 minutes, within 30 minutes nearly all the details have changed completely. In contrast to this, the large-scale network pattern seems relatively unchanged after 2½ hours. (3) Occasionally 'new' network, not resulting from the lateral motion of bright features from either previously existing network or sunspots, appears on the solar surface. This process consists of the formation in approximately 10 minutes of bright points and a darker-than-average feature between them. The dark feature disappears in another 5 to 10 minutes and the bright points separate at a relative speed of a few km · sec^{-1}. If the event is of a sufficiently large magnitude, a sunspot will appear. These observed changes of the photospheric network with time are interpreted as formation and motions of photospheric magnetic fields. It is suggested that these motions reflect the presence of both short-lived small-scale and long-lived large-scale photospheric currents such as one might expect from the granulation and the supergranulation. (auth)

3102 SPECTROHELIOGRAMS IN THE Mg II LINE AT 2795.5 A. Fredga, Kerstin (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 9: 358-71(Oct. 1969).

A rocket-borne spectroheliograph designed to take monochromatic pictures of the Sun in the Mg II line at 2795.5 Å was successfully launched from White Sands Missile Range on May 20, 1968. A double Solc birefringent filter with a spectral bandpass of 2.1 Å was used to select the proper wavelength. Pinhole photographs in the soft x-ray region were also secured in the same flight. The Mg II and x-ray photographs are compared with simultaneous Ca II and Hα spectroheliograms, radiomaps at 9.1 and 3.3 cm, a Fraunhofer map, and a magnetogram. Preliminary results are discussed. (auth)

3103 ON π COMPONENTS IN ZEEMAN-SPLIT LINES OF THE UMBRA SPECTRUM. Mehltretter, J. P. (Fraunhofer Inst., Freiburg, i. B.). Solar Phys., 9: 387-90(Oct. 1969).

In the period of May 23–29, 1967, spectra of a sunspot were taken on successive days in the wavelength region 6200 to 6350 Å with the domeless coudé refractor in Anacapri. Shortly before or after the spectroscopic observations, both the apparent umbral contrast and the aureole outside the solar limb were measured by photoelectric means. (W.D.M.)

3104 MEAN TEMPERATURE GRADIENT IN THE UMBRA. Wilson, P. R. Solar Phys., 9: 391-3(Oct. 1969).

Mattig (1969) re-examined various observations of the center-limb variation of mean umbral brightness and found that, unlike the mean photospheric limb-darkening, the ratio $I_u(\theta)/I_u(0)$ decreases only slightly with increase of heliocentric angle. He concludes that the mean temperature gradient in the umbra is very small below optical depths 0.2 and thus no spectral lines can be formed in this region. This conclusion is questioned. (W.D.M.)

3105 THE PROFILES OF FRAUNHOFER LINES IN THE PRESENCE OF ZEEMAN SPLITTING. I. THE ZEEMAN TRIPLET. Beckers, J. M. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys., 9: 372-86(Oct. 1969).

For the case of pure absorption lines (LTE) a method is described that enables the general computation of Zeeman-split line profiles. The magnetic field vector, the Doppler shift, and the line absorption coefficient is permitted to vary arbitrarily with optical depth. Elliptical birefringence (e.g., Faraday rotation) of the solar atmosphere is taken into account. Some numerical examples are given, and some interesting behaviors of the line profiles are discussed. (auth)

3106 ON H_2O IN SUNSPOTS. Woehl, H. (Univ., Goettingen, Ger.). Solar Phys., 9: 394-6(Oct. 1969).

In order to search for solar H_2O lines the author scanned photoelectrically, on several days in March 1969, absorption lines of H_2O in the spectra of sunspots and the surrounding photosphere at 5760 and 5880 Å. It is concluded that, to establish the identification of H_2O in sunspots, further observations are needed at high-altitude stations or by spacecraft to eliminate the influence of terrestrial H_2O. (W.D.M.)

3107 WILSON EFFECT AND THE TRANSPARENCY OF SUNSPOT MODELS. Jensen, E.; Brahde, R.; Ofstad, P. (Univ., Oslo). Solar Phys., 9: 397-419(Oct. 1969).

Hydrostatic models of sunspot penumbra and umbra were evaluated using Bode's tables of monochromatic absorption coefficients and $T-\tau$ relations given by Makita and Morimoto (1960) and Zwaan (1965). These models were placed side by side to simulate a complete sunspot corresponding to an area of 480×10^{-6} of a hemisphere. Intensity profiles were evaluated for aspect angles up to 85° and compared to observations. The primary aim was to study the influence of spot transparency, closely related to the gas pressure, on the Wilson effect and on other changes in the intensity profile that appear close to the solar limb. The gas-pressures at the zero-level in the geometrical depth (z = 0) corresponding to optical depth, $\tau = 10^{-3}$, both in the umbra, P_0^u, and in the penumbra, P_0^p, appear as adjustable parameters. (auth)

3108 MAGNETIC "KNOTS" IN THE SOLAR PHOTOSPHERE. Abdusamatov, H. I.; Krat, V. A. Solar Phys., 9: 420-2(Oct. 1969).

On May 30, 1968 at 0400 UT, spectrograms of magnetic "knots" in the vicinity of several dark pores in the group No. 206 were obtained. The pores were very unstable and disappeared during some subsequent hours. The brightness, radial velocity, and strength of the magnetic field were determined. (W.D.M.)

3109 SUNSPOT MOTION STATISTICS FOR 1965–67. Coffey, Helen E.; Gilman, Peter A. (Univ. of Colorado, Boulder). Solar Phys., 9: 423-6(Oct. 1969).

Sunspot motion statistics for the years 1965–67, based on Sacramento Peak Observatory data, are presented. These data are routinely available in the Geophysics and Space Data Bulletin of the AFCRL. The study complements the electron-corona differential rotation measurements for 1964–67 by Hansen et al., (1969), and also recent spectroscopic measurements by Livingston (1969). (W.D.M.)

3110 OBSERVATIONS OF ROTATIONAL MOTION IN PROMINENCES. Oehman, Yngve (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys., 9: 427-31(Oct. 1969).

Some recent observations carried out with the McMath Solar Telescope are reported, which can be interpreted as due to rotational motions in prominences. (auth)

3111 SPIN-FORBIDDEN RESONANCE MULTIPLETS IN LIGHT ELEMENTS. Edlen, B. (Univ. of Lund, Sweden); Palenius, H. P.; Bockasten, K.; Hallin, R.; Bromander, J. Solar Phys., 9: 432-8(Oct. 1969).

New laboratory data are presented on the multiplets $2s^2\ ^1S-2s2p\ ^3P$, $2s^22p\ ^2P-2s2p^2\ ^4P$, and $2s^22p^2\ ^3P-2s2p^3\ ^5S$ in nitrogen, oxygen, and fluorine, and the Z dependence of their wave numbers is discussed. These multiplets are very faint in laboratory light sources, but can become prominent in astrophysical sources of low density. Results confirm the solar identifications of the nitrogen and oxygen multiplets made by Burton et al. Predicted positions of the corresponding multiplets in neon are given. (auth)

3112 ON THE IDENTIFICATION OF Ar X AND Ar XIV IN THE SOLAR CORONA AND THE ORIGIN OF THE UNIDENTIFIED CORONAL LINES. Edlen, Bengt (Univ. of Lund, Sweden). Solar Phys., 9: 439-45(Oct. 1969).

A study of the Z dependence of the ^2P intervals of $2s^22p$ and $2s^22p^5$, aided by recent observational results, confirms the identification in the coronal spectrum of λ 4412 with Ar XIV, and of λ 5533.4 with Ar X. It is further shown that transitions from metastable levels in the configurations $3s^23p^k$ 3d, with k = 3, 4 and 5, of Fe XI, X, IX, and Ni XIII, XII, XI can well acount for the remaining unidentified coronal lines. (auth)

3113 PRELIMINARY REPORT ON PHOTOGRAPHING THE SOLAR CORONA IN 5303 A WITH A POLAROID AND A FABRY-PEROT INTERFEROMETER DURING THE TOTAL SOLAR ECLIPSE OF SEPTEMBER 22, 1968. Delone, A.; Makarova, E. (Sternberg Astronomical Inst., Moscow). Solar Phys., 9: 446-7(Oct. 1969).

An examination of the negatives revealed a striking absence of fine structure in the λ5303 line, in contrast to observations on the λ6374 line during the solar eclipse of May 30, 1965. (W.D.M.)

3114 DIFFERENTIAL ROTATION WITH HEIGHT IN THE SOLAR ATMOSPHERE. Livingston, W. C. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys., 9: 448-51(Oct. 1969).

Spectroscopic measurements of solar rotation having good height discrimination show no change in angular velocity through the photosphere layers but an increase of 8% for the Hα chromosphere (epoch 1968.9). Spectroscopic results in general are compared with measures made with tracers, i.e., sunspots, filaments, etc., and it is seen that the spectroscopic method always shows increased differential rotation with height, while tracers indicate none. A westward flowing wind is proposed that increases in velocity with height, but produces negligible movement to magnetic regions associated with tracers. (auth)

3115 MERIDIONAL (NORTH–SOUTH) MOTIONS OF THE SOLAR WIND. Siscoe, G. L.; Finley, L. T. (Univ. of California, Los Angeles). Solar Phys., 9: 452-66(Oct. 1969).

The steady state hydrodynamic equations which describe the solar wind flow are linearized and used to study the spatial behavior of zonal pressure perturbations. Such perturbations produce meridional (north–south) motions in the solar wind. To simplify the spatial dependence of the zero-order variables and to take advantage of the supersonic regime, the analysis is restricted to heliocentric distances greater than 0.1 AU (astronomical unit). A simplified problem involving a north–south magnetic field asymmetry is also treated. The emphasis of the paper is to determine what pressure perturbations are required at the inner boundary (0.1 AU) to produce at Earth north–south deviations from radial flow of 1° to 3°. (auth)

3116 TANGENTIAL DISCONTINUITIES IN THE SOLAR WIND. Burlaga, Leonard F.; Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 9: 467-77(Oct. 1969).

Six discontinuity surfaces are considered which were observed by magnetometers on 3 spacecraft in the solar wind. It is shown that the actual surface orientations, determined from the measured time delays and solar wind speed, are consistent with the theoretical orientations which were computed from the relation $\hat{n} = \hat{B} \times \hat{B}'$, where $\hat{n}$ is the normal to the surface of a hydromagnetic tangential discontinuity across which the magnetic field direction changes from $\hat{B}$ to $\hat{B}'$. The plasma and magnetic field data for these discontinuities are consistent with the pressure balance condition, and the magnetic field vectors in the associated current sheets are parallel to the discontinuity surface, as required theoretically. The 6 discontinuity surfaces extended without much distortion over ~0.002 AU. A seventh surface is discussed which satisfies the condition $\hat{n} = \hat{B} \times \hat{B}'$ but which extended without much distortion over 0.01 AU. This latter is not a typical surface, however, and its curvature is larger than average. Most of the surfaces tended to lie along the spiral direction, but one was nearly perpendicular to the spiral direction. (auth)

3117 IDENTIFICATION OF TWO SOLAR X-RAY SOURCES AT THE SEPTEMBER 22, 1968 TOTAL ECLIPSE. Meisel, David D. (Leander McCormick Observatory, Charlottesville, Va.). Solar Phys., 9: 487-93(Oct. 1969).

Study of nearly 200 records of radio signal strength indicates that a major portion of the ambient D-layer absorption on September 22, 1968 can be attributed to two strong x-ray sources. The hottest source was located on the the eastern limb and showed evidence of cooling from $T = (3.6 \pm 0.3) \times 10^6$K to $T = (2.7 \pm 0.2) \times 10^6$K over a 2½ h period. The other source was located near the western limb and showed no appreciable temperature change during the eclipse period. Except for the apparent source decay, the sources are similar to those found at previous eclipses using similar techniques (Meisel; 1968, 1969). (auth)

3118 ENHANCEMENTS OF INTERPLANETARY SCINTILLATION, COROTATING STEAMS, AND FORBUSH DECREASES. Burnell, J. (Univ. of Southampton, Eng.). Nature (London), 224: 356-7(Oct. 25, 1969).

Reference is made to an interplanetary survey of part of the northern sky made between July 1967 and Jan. 1968, using the 4-acre aerial at the Mullard Radio Astronomy Observatory, Cambridge (UK) to detect and measure the angular diameters of quasars and other compact radio sources at 81.5 MHz. Large increases (up to 200%) in scintillation of many radio sources were observed. It was found that most of the enhancements tended to recur with a period of 27 days, and that some correlated with decreases in cosmic-ray intensity. The magnitude of the enhancement observed on any particular day varied from source to source. The quantity $\Delta F/\overline{F}$ was calculated for each source (F is the scintillation index) and the values averaged over all the sources observed each day are shown graphically. Also shown is the cosmic-ray index, the average increase or decrease in scintillation, and ΣK_p for each day. Enhancements of scintillations which co-rotate with the Sun and which correlate with decrease in cosmic ray-intensity are indicated. Some co-rotating enhancements do not appear to correlate with cosmic-ray decrease nor with any co-rotating K_p maximum. There was some suggestion of a scintillation enhancement and Forbush decrease in observations by Dennison and Wiseman (Proc. Astron. Soc. Australia) made in May 1968, but because of limitations in the data this could not be definitely established. Other reports of anomalous scintillation enhancements are also mentioned. To a first approximation the observed scintillation index depends on the rms fluctuation in electron density at that point in the interplanetary medium where the line of sight to the radio source is closest to the Sun. The fluctuations are typically of a few magnitude and have a scale size of several hundreds of kilometers. An enhancement of scintillation would be produced by an enhancement of this rms fluctuation of electron density. The observations show that co-rotating streams and shocks are associated with increases in electron density fluctuations. It is considered that the phenomena might provide a good tool for probing the interplanetary medium outside the ecliptic plane. (UK)

3119 OBSERVATION OF STRONG CIRCULAR POLARIZATION IN A MOVING TYPE IV BURST. Kai, K. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 189-91(Mar. 1969). (RPP-1254).

A description is given of 80-MHz radioheliograph observations of an outburst in which it was possible to isolate the moving type-IV source and demonstrate that its circular polarization was strong (~80%). Hence it is shown that the energy of the radiating electrons cannot exceed 6×10^5 eV. (W.D.M.)

3120 CHROMOSPHERIC FLARE ENHANCEMENTS IN THE EXTREME ULTRAVIOLET AND THEIR RELATIONSHIP WITH SOLAR ABUNDANCES. Bowers, B. C. (Weapons Research Establishment, Salisburg, Australia). Nature (London), 224: 352-3(Oct. 25, 1969).

A relationship is suggested between the enhancement of a given line and the abundance of the element from which it is radiating. Measured enhancements are listed for a number of lines near the maximum of a 3-flare. When the percentage enhancements are compared with coronal relative abundances the correlation in some instances is high; reasons are given for a breakdown of the correlation for certain lines. The enhancement is unlikely to depend directly on the relative abundance of an element, but must depend on some atomic or subatomic property. Electron density may be a relevant criterion. (UK)

3121 SOLAR SOURCE OF INTERPLANETARY MAGNETIC FIELDS. Wilcox, J. M. (Univ. of California, Berkeley); Severnyi, A.; Colburn, D. S. Nature (London), 224: 353-4(Oct. 25, 1969).

Measurements of the mean magnetic field of the Sun, seen as a star, were made for the period March to June 1968 (Severny, Nature 224: 53(1969)), and it was pointed out that a close correlation of the solar field with the sector structure of the interplanetary magnetic field should be expected if the solar–interplanetary correlation described previously (Wilcox and Howard, Solar Physics 5: 564(1968)) existed at the time of the observations. A comparison of this solar magnetic field with the polarity of the interplanetary magnetic field observed near the Earth with magnetometry on Explorers 33 and 35 is shown, indicating a very close correspondence between these two magnetic fields. Agreement between solar and interplanetary fields could exist only if the solar source of the interplanetary field were part of a field pattern that is ordered over an appreciable portion of the solar disk. This is consistent with a diagram which shows a solar background field pattern derived from comparison of solar and interplanetary fields near the previous sunspot minimum. The total flux, divided by the area of the solar disk, is also shown for all sunspots; it is seen that the sunspot field is not closely related to the interplanetary field. Comparison of the mean solar field and the interplanetary field near solar maximum is consistent with the correlations and field patterns developed from analyses near solar minimum. (UK)

3122 HOMOLOGOUS BURSTS OF SPECTRAL TYPE II. Stewart, R. T.; Hardwick, B. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 185-6(Mar. 1969). (RPP–1256).

From dynamic spectra recorded in the frequency range 210 to 10 MHz at Dapto and later at Culgoora evidence has been found for homology within spectral Type II bursts which occur successively over a period of several days associated with flares from the same active region on the Sun. Examples of dynamic spectra and flare data are given. (W.D.M.)

3123 MOVEMENT AND STRUCTURE IN A COMPLEX SOLAR OUTBURST AT 80 MHz. Labrum, N. R. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 191-2(Mar. 1969). (RPP–1250).

On Oct. 30, 1968 a large solar flare (importance 3B to 4B) began at approximately 23: 42 UT. A preliminary account of the associated radio emission is presented. (W.D.M.)

3124 FABRY–PEROT INTERFEROGRAMS OF THE SOLAR Mg II DOUBLET AND XUV SOLAR IMAGES OBTAINED DURING A STABILISED SKYLARK ROCKET FLIGHT. Bates, B. (Queens Univ., Belfast); Bradley, D. J.; McKeith, C. D.; McKeith, N. E.; Burton, W. M.; Paxton, H. J. B.; Shenton, D. B.; Wilson, R. Nature (London), 224: 161-3(Oct. 11, 1969).

The resonance lines of Mg II occur at wavelengths (2802.7 Å, 2795 Å) just beyond the extinction limit of the Earth's atmosphere, and because of the high cosmic abundance of Mg these lines are important in uv astronomy. The H and K lines are sensitive indicators of solar chromospheric effects. Observations are reported which were obtained with an optically contacted Fabry–Perot interferometer, internally mounted in an echelle spectrograph, flown on a stabilized Skylark rocket launched from Woomera, S. Australia, on Dec. 4, 1968. The experiment was designed to give a spectral resolution of 0.03 Å, with spatial resolution of 6 arc S along a solar diameter. The payload also included a pinhole camera assembly to record monochromatic solar images at different wavelengths, including the extreme uv. The technique adopted is described in detail, and a recorded interferogram extending over 60 Å near the Mg II doublet is reproduced. Densitometer traces of a set of Mg II profiles are also shown. A marked feature is a wide variation in profiles over the solar disk. Most of the observed profiles show a double emission in the core, which usually is not symmetric. An analysis of of the profiles is given. Analysis of the profiles requires a knowledge of the distribution of activity over the solar disk, so that profile variations can be correlated with activity; this was the reason for inclusion of the pinhole camera. The observations indicated that the coronal xuv emission varies during the solar cycle in the same way as the white light corona. (UK)

3125 CORRELATED BURSTS AT DISTANT SOURCES ON THE SUN. Kai, K. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 186-8(Mar. 1969). (RPP–1258).

Apparently, correlated bursts with short time delays often occur in weak activity. However, it is most important for the study of the correlation to eliminate chance coincidences. In this paper some examples are presented of correlated bursts from separate distant sources which (i) occur suddenly in long quiet periods and (ii) are much stronger than the integrated quiet Sun. (W.D.M.)

3126 OBSERVATIONS OF MOTIONS IN A SOLAR STORM CENTER. McLean, D. J. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 188-9(Mar. 1969). (RPP–1255).

With a number of important exceptions associated with transitory flare activity, most persistent sources of solar radio emission observed to date with the 80-MHz Culgoora radioheliograph have been stable in position over periods of tens of minutes or hours even though they fluctuated greatly in intensity. During several hours on Nov. 11, 1968, however, some interesting activity that showed frequent changes in the position of a source was observed. This activity is discussed in some detail. (W.D.M.)

3127 INTERSTELLAR H_2^+ MOLECULE. Stecher, T. P. (Goddard Space Flight Center, Greenbelt, Maryland); Williams, D. A. Astrophys. Lett., 4: 99-102(Sept. 1969).

Interstellar extinction observations and the photodissociation cross section for H_2^+ give an upper limit of 3×10^{-4} cm^{-3} to the mean H_2^+ number density in interstellar space. Consideration of formation mechanisms suggests that sufficient H_2^+ may be present to contribute to interstellar extinction especially around young hot stars. The wavelength dependence of the extinction produced by H_2^+ is similar to that produced by grains except in the far ultraviolet where the extinction due to H_2^+ is relatively larger. (auth)

3128 BUOYANCY AND SOLAR SPIN-DOWN. Modisette, Jerry L.; Novotny, John E. (Manned Spacecraft Center, Houston, Tex.). Science, 166: 872-4(Nov. 14, 1969).

The transition of a cylinder of water with a vertical density gradient between convective and viscous spin-down occurs near the point at which the maximum buoyancy force equals the radial pressure gradient that is driving the convection. A similar analysis applied to the Sun shows the maximum buoyancy force to be 1500 times the convective force. A rapidly rotating solar interior would not be damped by large-scale convection. (auth)

3129 MAGNETIC FLUX-TRAPPING EXPERIMENT WITH A MOVING CONDUCTOR. Hovorka, John (Massachusetts Inst. of Tech., Cambridge). Science, 166: 877-8(Nov. 14, 1969).

An aluminum conductor moving into and out of a magnetic field of 75 gauss, traps within itself for varying lengths of time a detectable fraction of the encountered flux, which subsequently decays. A time constant of about 0.005 second, which is the order of magnitude predicted by classical electrodynamics, is measured. The result is of interest in connection with the "frozen-in field" concept of Babcock's sunspot model. (auth)

Galaxies

3130 A VERY HIGH-VELOCITY GAS CLOUD NEAR THE NUCLEUS OF NGC 4939. Burbridge, E. Margaret; Demoulin, Marie-Helene (Univ. of California, San Diego, La Jolla, Calif.). Astrophys. Lett., 4: 89-91(Sept. 1969).

A gas cloud about 750 pc from the nucleus of the spiral galaxy NGC 4939 has a radial velocity 700 km sec^{-1} less than that of the nucleus of the galaxy. The gas is most probably being ejected from the nucleus. (auth)

3131 GALACTIC EFFECTS OF THE COSMIC-RAY GAS. Parker, E. N. (Univ. of Chicago). Space Sci. Rev., 9: 651-712(Aug. 1969).

On an astronomical scale, cosmic rays must be considered a tenuous and extremely hot (relativistic) gas. The pressure of the cosmic-ray gas is comparable to the other gas and field pressures in interstellar space, so that the cosmic-ray pressure must be taken into account in treating the dynamical properties of the gaseous disk of the galaxy. This review begins with a survey of present knowledge of the cosmic-ray gas. Then the kinetic properties of the gas are developed, followed by an exposition of the dynamical effects of the cosmic-ray gas on a large-scale magnetic field embedded in a thermal gas. The propagation of low-frequency hydromagnetic waves is worked out in the fluid approximation. The dynamical properties of the gaseous disk of the galaxy are next considered. The equations for the equilibrium distribution in the direction perpendicular to the disk are worked out. It is shown that a self-consistent equilibrium can be constructed within the range of the observational estimates of the gas density, scale height, turbulent velocity, field strength, cosmic-ray pressure, and galactic gravitational acceleration. Perturbation calculations then show that the equilibrium is unstable, on scales of a few hundred pc and in times of the order 2×10^7 years. The instability is driven about equally by the magnetic field and the cosmic-ray gas and dominates self-gravitation. Hence the instability dominates the dynamics of the interstellar gas and is the major effect in forming interstellar gas clouds. Star formation is the end re-

sult of condensation of the interstellar gas into clouds, indicating, then, that cosmic rays play a major role in initiating star formation in the Galaxy. The cosmic rays are trapped in the unstable gaseous disk and escape from the disk only in so far as their pressure is able to inflate the magnetic field of the disk. The observed scale height of the galactic disk, the short life (10^6 years) of cosmic-ray particles in the disk of the Galaxy, and their observed quiescent state in the disk, indicate that the galactic magnetic field acts as a safety valve on the cosmic-ray pressure P so that $P \cong B^2/8\pi$. From the observed life and quiescence of the cosmic rays it is inferred that the mean field strength in the disk of the Galaxy is 3 to 5×10^{-6} gauss. (auth)

3132 WAVE PHENOMENA IN THE INTERSTELLAR PLASMA. Lerche, I. (Univ. of Chicago). Advan. Plasma Phys., 2: 47-138(1969).

The following topics are discussed: (1) composition of the interstellar medium, (2) hydromagnetic waves and instabilities, (3) diffusion and hydromagnetic waves, (4) resonant wave–particle disturbances, and (5) supraluminous plasma waves and fluctuation radiation. (M.O.W.)

3133 DYNAMICAL EVOLUTION OF CLUSTERS OF GALAXIES. III. Aarseth, S. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 537-48 (1969).

Previous numerical studies of simulated galaxy clusters are extended to include rotation. The initial velocity distribution contains 26 retrograde and 74 direct orbits. The inclusion of rotation shortens the mean relaxation time and gives rise to a significant flattening. A large proportion of positive angular momentum is transferred to the halo, but the flattening remains frozen in. There is preferential escape of direct orbits, but two out of 20 escapers are retrograde. The direct escapers do not carry away any excess angular momentum per unit mass, but the loss of rotational energy is increased considerably by the removal of 61 distant halo orbits. After a total integration time of 139 initial crossing times the cluster contains 19 bodies, representing 37.5% of the total mass and only 13% of the angular momentum. An upper limit of 370 initial crossing times is estimated for the time to lose all nonnuclear members inside $r \simeq 10$ by replacing the compact nucleus with one central body. Six further cases with different types of rotation were also studied in order to explore the initial condition dependence. There is significant correlation between total angular momentum and flattening, but fluctuations can mask the rotation effect when the rotational energy is small. (auth) (UK)

3134 EVIDENCE FOR A GALACTIC COMPONENT OF THE DIFFUSE X-RAY BACKGROUND. Cooke, B. A.; Griffiths, R. E.; Pounds, K. A. (Univ. of Leicester, Eng.). Nature (London), 224: 134-7(Oct. 11, 1969).

It is stated that rocket measurements have shown an excess of radiation in the galactic plane in the Vela–Carina–Centaurus region. The evidence for this is described and possible explanations are considered. (auth) (UK)

3135 SPIN TEMPERATURE OF THE INTERSTELLAR NEUTRAL HYDROGEN. Radhakrishnan, V.; Murray, J. D. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 215-16(Mar. 1969). (RPP-1260).

In an attempt to sample the temperature of the neutral hydrogen in as direct a manner as possible, observations were made using the Parkes 210-ft reflector in the directions of 35 extragalactic sources. These sources are located at intermediate or high galactic latitudes in which directions relatively local hydrogen is observed. The variation of the emission in the neighborhood of the sources was investigated and found to be either negligible or linear in most cases. (W.D.M.)

3136 INTERSTELLAR ABSORPTION IN THE DIRECTION OF THE CLUSTER IC 1805. Divan, Lucienne; Burnichon, Marie-Louise (Institut d'Astrophysique, Paris). Compt. Rend., Ser. B, 269: 94-6(July 16, 1969). (In French).

The results of a spectrophotometric study of interstellar absorption in the IC 1805 region are presented. The problem of the form of the absorption rule is examined. It is shown that at least part of the absorbing material is located very far from 0 stars having a mass which can have an effect on it. The possibility of considerable anomalies but relating to only a small fraction of the absorbing material is considered. (tr-auth)

3137 FORMATION OF PROTOGALAXIES AND MOLECULAR PROCESSES IN HYDROGEN GAS. Hirasawa, Toshiaki (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 42: 523-43(Sept. 1969).

As one stage of galaxy formation the gravitational contraction of a cold gas due to the radiative cooling by hydrogen molecules was studied. Assuming that the gas consists mainly of hydrogen atoms, all possible atomic and molecular processes in the gas were considered and it was found that H_2 molecules are formed most efficiently by way of H^- formation: $H + e^- \rightarrow H^- + h\nu$ and $H^- + H \rightarrow H_2 + e^-$. The contraction of a gas cloud was studied in the wide range of initial conditions and it was found that sufficient amounts of H_2 are formed in the gas cloud so that it can evolve into a protogalaxy provided that the radiation temperature is less than 300°K. The effect of He and D on the cooling was also examined and it was found that their effect is negligible. (auth)

Cosmology

Refer also to abstract 3206.

3138 FINITE ROTATING UNIVERSE. Ozsvath, Istvan (Southwest Center for Advanced Studies, Dallas); Schuecking, Engelbert L. Ann. Phys. (N. Y.), 55: 166-204(Oct. 15, 1969).

On the Lie group $R \times S^3$ a left invariant metric is constructed, which satisfies the Einstein field equations with incoherent matter. The Riemannian space, M_4, obtained this way is designated the Finite Rotating Universe, since the normal subgroup S^3 constitutes the (finite) space sections of M_4, and the matter rotates. The geometry of M_4 and its relation to one version of Mach's principle are discussed. (auth)

3139 MATTER–ANTIMATTER INTERACTIONS. Steigman, Gary. New York, New York Univ., 1968. 142p.

Thesis.

The symmetry of the laws of nature regarding particles and antiparticles leads to the speculation that the abundance of matter and antimatter in the universe may be equal. The validity of such a proposal can only be established by experimental verification. The existence of antimatter on a large scale in the universe depends strongly on the character of the initial state and so its detection can serve to limit the number of available cosmologies. The effects of matter–antimatter collisions yield the most hopeful means for establishing the existence of antimatter. This is what is examined. Various competing processes that lead to annihilation are considered. For ionized matter–antimatter encounters, direct annihilation competes with radiative recombination into positronium and/or protonium. In collisions between atoms and antiatoms, positrons, and antiprotons, formation of positronium and/or protonium compete with direct annihilation. Such collisions at low velocities ($v \lesssim 10^8$ cm/sec, $v \lesssim \alpha c$) are especially significant, their cross sections being of atomic rather than nuclear dimensions. Slow collisions ($v \lesssim \alpha c$) are dealt with in a semi-classical, adiabatic approximation. Intermediate energy collisions ($\alpha c \lesssim v \lesssim c/2$) are handled in the Born approximation and by a classical method. Direct annihilation and radiative recombination are also considered. Roughly, for $v \leq 10^{-1}$ c, direct annihilation dominates. The fate of the antiproton is also discussed. It is shown that no antimatter is expected to coexist with matter on a galactic scale, a result confirmed by the Explorer II and Ranger 3 and 5 experiments. If antimatter is present in the universe on a large scale, it is probably to be found in separate antigalaxies. The results of a collision between such an antigalaxy and an ordinary galaxy are considered. Such collisions are of the slow type ($v \leq \alpha c$) and thus yield large matter–antimatter interaction cross sections. The annihilation lifetime for an antiparticle in the presence of n particles per cm^3 is: $\tau_{ANN} \approx 10^{10}\, n^{-1}$ sec. Most important in galaxy–antigalaxy collisions are gas–antigas encounters and cloud–antigas encounters. The energy deposited in the colliding galaxies in the form of 100-MeV electrons and positrons is related to the expected gamma ray flux. Existing evidence in the form of discrete gamma ray fluxes from various quasars does not rule out the possibility that they may be galaxy–antigalaxy collisions. A discussion of the existing evidence in the form of cosmic rays, cosmic gamma rays, quasars, radio galaxies, etc. is presented. (Disser. Abstr.)

3140 ADVANCES IN PLASMA PHYSICS. VOLUME 2. Simon, Albert; Thompson, William B. (eds.). An Interscience Series. New York, John Wiley and Sons, Inc., 1969. 217p. $13.50.

Separate abstracts were prepared for the three review-type articles. (M.O.W.)

For abstracts of individual papers see: 3132, 3327, and 3228.

3141 DYNAMICS OF SELF-GRAVITATING GASEOUS SPHERES. III. ANALYTICAL RESULTS IN THE FREE-FALL OF ISOTHERMAL CASES. Penston, M. V. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 425-48(1969).

For a cold gas the analytical solutions for collapse in various

symmetries give density and velocity profiles at the instant when a singularity develops in the initially densest part. These profiles follow generally from assuming that the density variation is smooth initially. For spherical and planar symmetries these solutions were extended to a short time before this singularity occurs. The spherical results imply a density law proportional to $r^{-8/5}$. The solutions before the singularity arises are similarity solutions with the density and velocity profiles retaining their shapes while altering only their scales with time. Applying these results it is found that a spherical collapse to form a galaxy is modified by the rise in central optical depth at a density of $\sim 10^{-20}$ g cm^{-3}. Flattening instabilities are resisted but not overcome by the more rapid growth of the density gradient which occurs in a planar collapse. A similarity solution for the spherical collapse of an isothermal gas is presented. This has a critical point similar to those found in solar wind flows. The density profile when the singularity arises is proportional to r^{-2}. The collapse of a photostar is halted by the rise in optical depth when the density reaches 10^{-18} g cm^{-3}. The stability of this solution and the problem of whether all flows converge to it remain to be settled. (auth) (UK)

3142 GRAVITATIONAL INSTABILITY IN THE BRANS–DICKE COSMOLOGY. Nariai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 42: 544-54(Sept. 1969).

In view of a possible relevance of the Brans–Dicke cosmology to the resolution of the primeval helium problem and the problem of galaxy formation, the gravitational instability in their cosmology is studied by the use of Lagrangian gauge. It is shown that the density contrast consists, in general, of four independent terms, i.e., two terms resembling their counterparts in general relativistic cosmology and the other two due to the variation of the gravitation "constant." At the later stage of the Universe, the density contrast can grow in time. It is also shown that Mach's principle in the sense of Dicke provides one with some close connection between the last two terms and the time-growing term. (auth)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

3143 RANGES OF NITROGEN IONS IN Se AND ENERGY LOSSES OF ALPHA PARTICLES IN Al, Ni, Se, Ag, AND Au. Nakata, Hiroshi (Natural Science Research Society, Kawasaki, Japan). Can. J. Phys., 47: 2545-52(Nov. 15, 1969).

The range–energy relation of N^{3+} in Se was obtained from an energy-loss curve in the energy range 1 to 12 MeV. The results are slightly smaller than expected from theory. The ranges in Se were found to be different from ranges previously determined in Al, Ni, Ag, and Au. This difference was confirmed by energy-loss measurements for alpha particles in Al, Ni, Se, Ag, and Au. (auth) (Canada)

3144 POLARIZED ELECTRON BEAMS. Mayne, K. I. (Univ. of Edinburgh). Contemp. Phys., 10: 387-412(1969).

A beam of electrons may have the spins of the individual electrons preferentially polarized in a specified direction. The resulting state of polarization of the electron beam is described by a polarization vector P. This polarization vector is affected in direction and magnitude by macroscopic electric and magnetic fields. The relevance of this to precise measurement of the electronic g factor, and to the problems of handling polarized beams (as in accelerating systems), is discussed. Some spin-sensitive interactions, and various methods of producing intense highly polarized electron beams, are discussed. An outline is given of the mathematical formalism used in describing polarization phenomena. (auth) (UK)

3145 ANISOTROPY OF ELECTRON ENERGY LOSS SPECTRA IN ANTHRACENE SINGLE CRYSTALS. Kunstreich, S.; Otto, A. (Univ., Munich). Opt. Commun., 1: No. 2, 45-6(May 1969).

Energy-loss spectra of 30-keV electrons transmitted through anthracene single-crystal foils were measured at non-normal incidence and at different scattering angles. The loss energy and intensity were found to depend on the direction of the transferred momentum relative to the crystal axes. The loss at about 6 eV cannot be interpreted as a π-electron plasmon. (auth)

3146 EXCITATION OF Cu ATOMS BY Ar IONS AND SUBSEQUENT RADIATIONLESS DEEXCITATION OF SCATTERED PARTICLES NEAR A Cu SURFACE. Van Der Weg, W. F.; Bierman, D. J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 44: 206-18(Sept. 15, 1969).

The profile of a Cu I spectral line excited by bombardment of a Cu crystal with 80-keV Ar ions is measured. The Doppler profile shows that the light-emitting particles have energies in the keV region. The wavelength shift of 0 to 0.5 Å depends on crystal and monochromator orientation. Measurements of the line shape as a function of the angle of the target with respect to the primary beam and also as a function of azimuthal rotation of the target, indicate that the emitting particles originate predominantly from collisions of Ar ions with surface Cu atoms. The fact that the emission is found in front of the target points in the same direction. Evidence is presented for the occurrence of a radiationless de-excitation process, which is supposed to be tunnelling of an electron from the excited atom into the metal. The probability for escape from the surface in an excited state depends therefore on the particle velocity. A calculation of the line profile based on this assumption is made. Comparison with the experiments yields a value 10^{14} sec^{-1} for the transition rate for the tunnelling process when the distance from excited atom to metal surface is a few Å. (auth)

3147 COLLISIONS OF Ar^+ IONS WITH SURFACE Cu ATOMS AND CHARGE EXCHANGE OF SCATTERED IONS NEAR THE METAL SURFACE. Van Der Weg, W. F.; Bierman, D. J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 44: 177-205(Sept. 15, 1969).

Absolute intensities of scattered projectile and recoil ions resulting from large-angle collisions of 60- and 90-keV Ar^+ ions in a (100) surface of a solid Cu target are presented. These intensities are studied as a function of scattering angle and also as a function of the angle between the direction of emerging ions and the surface. A model is proposed, which interrelates the observed ion yields in the cases of ion–surface-atom scattering and ion–gas-atom scattering. This model describes the collision of an ion with a surface atom in two phases. The first phase essentially neglects any interaction of the two collision partners with the metal surface and therefore is exactly the same as the model to describe ion–free-atom collisions. The second phase starts after the moment that ion formation has taken place and consists of a continuous interaction of the scattered ions with the surface on their path to the analyzer. The interaction is assumed to be charge exchange of the ions by capture of metal electrons. These processes are found to have rates of about 10^{15}/sec depending on charge state and metal-ion distance. (auth)

3148 SPECTROSCOPIC IDENTIFICATION OF EXCITED ATOMIC AND MOLECULAR STATES IN ELECTRON-BOMBARDED LIQUID HELIUM. Dennis, W. S.; Durbin, E.; Fitzsimmons, W. A.; Heybey, O.; Walters, G. K. (Rice Univ., Houston, Tex.). Phys. Rev. Lett. 23: 1083-6(Nov. 10, 1969).

Optical and infrared emission spectra of electron-bombarded liquid helium reveal the presence of a number of excited singlet and triplet states of the He_2 molecule, including the $a^3\Sigma_u^+$ metastable state. The observed liquid spectra show vibrational and unresolved rotational structure. There is also preliminary evidence that excited atomic states, including the metastable 2^3S_1 state, are populated in the liquid. (auth)

3149 MOMENTUM AND ENERGY EXCHANGE BETWEEN BEAMS OF PARTICLES INTERACTING BY YUKAWA-TYPE POTENTIALS. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Phys. Rev.: 187: 382-92(5 Nov 1969).

A statistical theory of the momentum and energy exchange between beams of particles interacting by Yukawa-type potentials is presented. A theoretical description is given for the slowing down of the beams, the thermalization and heating of the beams, and the establishment of the isothermal state in the beams. The associated collision integrals are evaluated, with consideration of the velocity dependence of various Coulomb logarithms. The kinetic processes are shown to depend crucially on whether the relative velocity of the beams is supersonic or subsonic. The theory is applicable to (i) beams of charged and neutral particles interacting by a Coulomb potential screened by bound electrons, and (ii) beams of charged particles interacting by a Coulomb potential screened by free charges. In the region of low energies, the results are applicable to the components of collision-dominated ionized gases and plasmas, and represent an essential contribution to the transport theory of collision-dominated media with nondivergent Coulomb interactions. (auth)

3150 ENERGY STRAGGLING OF HEAVY CHARGED PARTICLES IN THICK ABSORBERS. Payne, M. G. (Berea Coll., Ky.). Phys. Rev., 185: 611-23(Sept. 10, 1969).

The theory of energy straggling attempts to calculate F(E,S), where F(E,S)dE is the fraction of the heavy charged particles having an energy between E and E + dE after a path length S has been traversed in absorbing medium. A method is developed for calculating F(E,S) for path lengths large enough so that F(E,S) is almost Gaussian. The method remains valid until a large

fraction of the particles run out of energy. The theory is applied to calculations of F(E,S) for 50-MeV protons in Be and for 5.3-MeV α particles in air. The calculations for α particles in air are in good agreement with the experimental results of Rotondi and Geiger. The theory is also in agreement with numerical calculations by Tschalär. (auth)

3151 A METHOD FOR MEASURING THE ENERGY LOSS OF 92 keV ^{237}Np IONS IN TRAVERSING THIN FILMS. Ambrosi, D. A.; Wolfson, J. L. (Univ. of Saskatchewan, Regina, Can.). Nucl. Instrum. Methods, 74: 251-5(1969).

A time-of-flight method is described for measuring the energy loss of 92-keV ^{237}Np ions in traversing a thin film of collodion. An alpha particle from the decay of ^{241}Am to ^{237}Np triggers the start of a time-of-flight circuit. The recoiling ^{237}Np ion subsequently decays in flight by emitting a 59.54-keV quantum, or L x ray. Detection of one or other of these actuates the stop circuit. Measurements with and without the intervening film permit calculation of the energy loss in traversing the film. (auth)

Atomic and Molecular Properties

3152 MOLECULAR SCHROEDINGER EQUATION. X. POTENTIAL SURFACES FOR GROUND AND EXCITED STATES OF ISOSCELES H_3^{++} AND H_3^+. Conroy, Harold (Carneige-Mellon Univ., Pittsburgh). J. Chem. Phys., 51: 3979-93(Nov. 1, 1969).

Accurate potential-energy surfaces are reported for the ground states, and for several excited states, of the isosceles triangular configurations of the molecular ions H_3^{++} and H_3^+. The ground states are $^2A_1$ and $^1A_1$, respectively, of group C_{2v}, and these include the Σ_g linear symmetric forms and the A_1' states of the equilateral D_{3h} triangles. The four excited-state surfaces are $^2B_1$ and $^2B_2$ for H_3^{++}, as well as $^1B_1$ and $^1B_2$ for H_3^+; these include the Π_u and Σ_u states of the linear $D_{\infty h}$ ions and the A_2'' and E' states of the D_{3h} ions. These excited states are of possible interest in connection with ultraviolet spectroscopic studies of H_3^+, long known from mass spectrometry to be a stable species. Each of the six surfaces is given in analytic form, and as an energy contour map. The two-electron wave functions used are basically of the configuration type, with an extensive additional treatment of electron correlation. In all cases the required matrices were computed with the new Diophantine integration scheme, which supersedes the now obsolete Monte Carlo method employed in our earlier papers on H_3^+. (auth)

3153 LOWER BOUNDS AND ESTIMATION OF ENERGY EIGENVALUES IN A GAUSSIAN BASIS. Mazziotti, Alexander (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 51: 4013-6 (Nov. 1, 1969).

Lower bounds to the ground-state energy of the helium atom are computed in the Gaussian framework. Comparison is made between the lower bounds obtained using variationally optimized upper-bound wave functions and the best lower bounds obtained by complete optimization of all parameters. There is a large improvement in the latter. Conroy's method of estimating eigenvalues is tested for the first time in a Gaussian basis, giving relatively poor results. An alternative method of estimating eigenvalues, based upon the partitioning of spectral impurities, is presented. The results of computations with this method are seen to be quite good. (auth)

3154 AUTOIONIZING AND NEGATIVE-ION STATES IN NEON. Grissom, J. T.; Garrett, W. R.; Compton, R. N. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 23: 1011-14 (Nov. 3, 1969).

The trapped-electron spectrum of Ne was measured in the energy region from 40 to 50 eV. New negative-ion resonances are observed. (auth)

3155 DISSOCIATION ENERGY AND IONIZATION POTENTIAL OF MOLECULAR HYDROGEN. Herzberg, G. (National Research Council of Canada, Ottawa). Phys. Rev. Lett. 23: 1081-3(Nov. 10, 1969).

The small discrepancy between experimental and theoretical values for the dissociation energies of H_2, HD, and D_2 was resolved by new measurements of the ultraviolet absorption limits of these molecules. In addition, the ionization potential of H_2 has been more accurately determined from Rydberg series. The agreement between theory and experiment must be considered very satisfactory. (auth)

3156 THEORY OF THE RELATIVISTIC H ATOM AND POSITRONIUM. Barut, A. O.; Baiquni, A. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 184: 1342-5(Aug. 25, 1969).

It is shown that a relativistic infinite-component wave equation correctly describes the relativistic effects in the H atom including the motion of the nucleus. An exact mass formula for the singlet $l = n - 1$ levels of positronium is derived. (auth)

3157 MEASUREMENT OF THE FINE-STRUCTURE CONSTANT BY LEVEL CROSSING IN ATOMIC HYDROGEN. Metcalf, Harold Joseph. Providence, Brown Univ., 1968. 90p.

Thesis.

The technique of level-crossing spectroscopy has been extended to the vacuum ultraviolet region of the spectrum. The crossings of two hyperfine sublevels of the $^2P_{\frac{1}{2}}$ state with two hyperfine sublevels of the $^2P_{\frac{3}{2}}$ state of atomic hydrogen have been observed at about 3500 gauss by monitoring part of the change of the spatial distribution of resonantly scattered Lyman-α radiation. These crossings are described by a theory that includes the hyperfine structure, radiative and reduced mass corrections, and relativistic corrections to the Zeeman effect. The value of the fine-structure constant calculated from the magnetic field measured at the center of the level crossing signal is $\alpha^{-1} = 137.0408 \pm .0028$ where the uncertainty is one standard deviation. This number is compared to other published values and discussed in the light of current discrepancies in the value of α. (Diss. Abstr.)

3158 WIDTHS OF THE $K\alpha_1$ AND $K\alpha_2$ X-RAY LINES FOR $Z > 50$. Nelson, G. C.; John, W.; Saunders, B. G. (Univ. of California, Livermore). Phys. Rev., 187: 1-5(5 Nov 1969).

A Cauchois-type transmission bent-crystal spectrometer has been used to measure the full width at half-maximum of the $K\alpha_1$ and $K\alpha_2$ x rays of 36 elements from Sb to Am. The x-ray lines were fitted by folding a Lorentzian natural line shape with a Gaussian instrumental response and integrating over the detector-slit width. The present results are systematically somewhat higher than the values deduced from recent theoretical calculations of the radiative widths and the appropriate experimental fluorescent yields. (auth)

3159 HYPERFINE STRUCTURE OF THE GROUND STATE OF $^3He^+$ BY THE ION-STORAGE EXCHANGE-COLLISION TECHNIQUE. Schuessler, H. A.; Fortson, E. N.; Dehmelt, H. G. (Univ. of Washington, Seattle). Phys. Rev.; 187: 5-38(5 Nov 1969).

The hfs of the ground state of $^3He^+$ has been studied using the spin-dependent collision processes between stored $^3He^+$ ions and a polarized beam of Cs atoms. All possible hfs transitions have been measured in a magnetic field of about 7.13 G. A consecutive-pulse multiple-resonance scheme was developed to detect the only weakly field-dependent transition $(F = 0, m_F = 0) \nrightarrow (F = 1, m_F = 0)$ in an almost ideally isolated and pure atomic system. Magnetic-resonance disorientation is observed as a change in the number of ions remaining in the rf quadrupole ion trap after a fixed interaction time with both the resonant rf fields and the polarized atomic beam. For the detection of an ion-number signal, the ion macromotion at ω_z was coherently excited by a homogeneous electric field at $\omega_z + \Omega$, where Ω is the frequency of the inhomogeneous rf field used for trapping. Linewidths of 10 Hz have been measured for the $(0,0) \nrightarrow (1,0)$ hfs transition, when the transition was induced during a time of the order of half the electron-spin orientation time in a weak atomic beam. The value for the zero-magnetic-field hfs splitting is $\Delta\nu = (8\ 665\ 649\ 867 \pm 10)$ Hz. Rate equations for the populations of the hfs Zeeman levels in the presence of the polarized atomic beam and transitions caused by various rf fields are given. Features of the line shape caused by the consecutive-pulse multiple-resonance scheme are also considered. Several mechanisms that may ultimately limit the precision are discussed. A comparison of the experimental result with current theories of the hfs of hydrogenic systems is presented. (auth)

3160 ATOMIC SUSCEPTIBILITIES AND SHIELDING FACTORS. Feiock, F. D.; Johnson, W. R. (Univ. of Notre Dame, Ind.). Phys. Rev.; 187: 39-50(5 Nov 1969).

A calculation of electric and magnetic susceptibilities and shielding factors for closed-shell atomic systems based on relativistic Hartree–Fock–Slater (RHFS) electron theory is presented. Numerical results are given for the electric dipole and quadrupole, and for the magnetic dipole and octupole cases for closed-shell atoms and ions from $Z = 2$ to $Z = 92$. Comparison is made with previous nonrelativistic uncoupled Hartree–Fock calculations and with experiment. (auth)

3161 ROLE OF f ELECTRONS IN THE CHEMICAL SHIFT OF THE $K_{\alpha 1}$ LINES. Smirnov, Yu. P.; Sumbaev, O. I.; Petrovich, E. V.; Zykov, V. S.; Egorov, A. I.; Grushko, A. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zk. Eksp. Teor. Fiz., 57: 1139-47(Oct. 1969). (In Russian).

The energy shifts of the $K_{\alpha 1}$ lines appearing on removal of 4f electrons from the atom (C_{4f} coefficients) are measured for the rare earth elements Ce, Pr, Tb, Sm, Eu, and Yb. The experimental results are compared with the theoretical calculations based on the self-consistent Dirac–Slater model. Good quantitative agreement between the experimental and theoretical C_{4f} coefficients is observed. (auth)

3162 ENERGY LEVELS OF THE HYDROGEN ATOM IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Demkov, Yu. N.; Monozon, B. S.; Ostrovskii, V. N. (Leningrad State Univ.). Zk. Eksp. Teor. Fiz., 57: 1431-4(Oct. 1969). (In Russian).

First and second perturbation-theory approximation values of the energy-level splitting of the hydrogen atom in uniform electric and magnetic fields of arbitrary mutual orientation are obtained. Symmetry of the four-dimensional Fock rotational group is used. Relativistic corrections and the spin–orbit interaction are not introduced. In a first approximation, the result is the same as that obtained by the earlier Bohr theory. Cases are considered when degeneracy is not completely removed. In particular, the case of mutually perpendicular electric and magnetic fields is analyzed. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 3584.

3163 LIFETIMES OF POSITRONIUM EXCITED STATES IN MEDIA. Urbanovich, S. I. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 3, 109-11 (1969). (In Russian).

The contribution of excited states of the positronium atom to the intensity of the long-lived component is considered. It is shown that the nS-states of positronium in the medium, because of the presence of mechanisms that compete actively with the radiation processes, are not metastable. Even in weak fields of the medium in a time comparable to the magnitude of the life of the long-lived component, cascade transitions to the ground state of positronium occur. The same conclusion is extended to the case of gases. Numerical estimates are presented. (tr-auth)

Collision Phenomena

Refer also to abstract 3149.

3164 (CEA-CONF-1292) COLLISIONAL DISSOCIATION OF HYDROCARBON IONS. Guidini, J.; Julienne, A.; Roussel, M.; Valckx, F. P. G. ([Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires]). [1968]. 13p. (In French). (CONF-690428-1). Dep. CFSTI (U. S. Sales Only).

From 3rd National Conference on Electronics and Atomic Collisions, Toulouse, France.

A primary ion beam of CH_n^+ (with n varying from 1 to 5) was accelerated between 40 and 50 kV on to a hydrogen target. The reactions produced are exoenergetic and the separation energy is transformed into kinetic energy distributed among the dissociation products. The energy spectra of H_2^0, H^0, H^+, and H_2^+ were measured and the effective cross sections for the formation of H^0 and H_2^0 from CH_4^+ and CH_3^+ were estimated. (tr-auth)

3165 (GA-9713) ENERGY DEPOSITION STUDIES. Annual Report. Vroom, D. A. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 26, 1969. Contract AT(04-3)-167. 84p. Dep. CFSTI.

Measurements of energy and angular distributions of ionization electrons ejected from Ar and N_2 by electron impact are described. Results are given for electron impact energies of 1 to 15 keV. Work on dissociative excitation of hydrogen-containing molecules by electron impact is summarized. No specific results are given. Three preprints of papers submitted for publication are included. (A.G.W.)

3166 (ORO-3650-2) CHARGED PARTICLE INTERACTION WITH NOBLE GASES. Annual Progress Report, April 15, 1968–April 14, 1969. Hurst, G. S. (Kentucky Univ., Lexington. Dept. of Physics and Astronomy). Dec. 1968. Contract AT(40-1)-3650. 52p. Dep. CFSTI.

Progress is reported briefly on the following: proton excitation of the Ar atom, Jesse effects and quenching of continuous emission in Ar, radiation transport theory, and proton excitation of the He atom. A mechanism is tentatively proposed to obtain recent results concerning the Jesse effect in Ar. In work on the Franck–Condon process in Ar, a cross section for the process of 4×10^{-19} cm^2 was obtained. New facilities and experimental designs are described briefly. A reprint of a published paper and a preprint of a paper to be published on proton excitation of the Ar atom are included. (A.G.W.)

3167 A MODEL FOR ELECTRON SCATTERING WHICH INCLUDES CORRELATION EFFECTS. Peat, F. D. (National Research Council of Canada, Ottawa). J. Phys., B (London), 2: 1120-1(Oct. 1969).

A model for electron scattering by an atom is proposed in which, outside the atom, correlation between the incident electron and the atomic electrons is neglected. A description using Green functions is indicated. Results of a calculation for electron scattering by hydrogen atoms based on this model are given. (auth) (UK)

3168 THE 2s AND 2p EXCITATIONS OF HYDROGEN BY PROTON AND HELIUM-ION IMPACT. Flannery, M. R. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). J. Phys. B (London), 2: 1044-54(Oct. 1969).

A general formula describing the direct interaction between a hydrogen atom and a positive ion with one electron is derived, and Born and two-state and four-state impact-parameter treatments are carried out for the processes $H(1s) + He^+(1s) \rightarrow H(2s \text{ or } 2p) + He^+(1s)$ with incident hydrogen energies in the range $4 \leq E \leq 625$ keV. The four-state calculation takes full account of distortion, back-coupling, rotational coupling and the virtual transition sequence $1s \approx 2p \approx 2s$. The long-range 2s–2p dipole coupling produces a marked effect on the 1s–2s excitation cross section, which in the Born and two-state treatments is determined solely by short-range interactions. The rotational coupling and distortion (both long-range in this case) exhibit a much greater influence on the 2p cross section than was in evidence for the excitation of hydrogen by neutral hydrogen or helium. Comparison with a four-state treatment of the excitation of hydrogen by proton impact demonstrates that, at moderate and high velocities, the orbital electron so effectively screens the helium nucleus that the helium ion behaves almost exactly as a singly charged structureless particle. The proton–hydrogen results are also compared with the second Born-wave calculations of Moiseiwitsch and his associates (1954 and 1965). The percentage polarization of the emitted Lyman-α radiation for both proton and helium-ion impact is also determined. (auth) (UK)

3169 COLLISIONAL EXCITATION OF He^+ IONS BY CARBON ATOMS. Yager, R. E.; Lane, N. F. (Rice Univ., Houston, Tex.). J. Phys., B (London), 2: 1060-8(Oct. 1969).

Upper and lower bounds to the Born approximation cross sections were calculated for the excitation of ground-state He^+ ions in collisions with free carbon atoms. Transitions to all orbital angular momentum states in the levels n = 2 to n = 7 were considered at incident He^+ laboratory energies between 0.504 and 6.472 MeV. A single Slater determinant was used to represent the carbon wave function, thus allowing a closed-form sum over all final states of the carbon atom. (auth) (UK)

3170 DISSOCIATION AND CHARGE TRANSFER IN 1.4 TO 46-keV H_2^+–H_2 COLLISIONS. Latimer, C. J.; Browning, R.; Gilbody, H. B. (Queen's Univ., Belfast). J. Phys., B(London), 2: 1055-9(Oct. 1969).

Cross sections for the formation of secondary H_2^+ and H^+ ions when 1.4- to 46-keV H_2^+ ions pass through thin targets of hydrogen were determined using a mass spectrometer designed to ensure that all secondary ions were recorded with a high and uniform efficiency. The influence of vibrational excitation of the H_2^+ primary ions on the observed yields of the slow H_2^+ and H^+ ions was also investigated. The results were used to take account of dissociative processes in the derivation of the symmetrical charge-transfer cross section σ_1 for the process $H_2^+(v = 0) + H_2(v = 0) \rightarrow H_2(\Sigma v) + H_2^+(\Sigma v)$ using the previous experimental data of McClure (1963 and 1965). Upper and lower bounds for σ_1 were estimated for energies within the range considered and these values lie considerably below the theoretical cross sections due to Bates and Reid (1969). (auth) (UK)

3171 ASYMPTOTIC EXPRESSION FOR 1s–ns EXCITATION CROSS SECTION OF H ATOMS BY FAST PROTONS. Khandelwal, G. S.; Fitchard, E. E. (Old Dominion Coll., Norfolk, Va.). J. Phys., B (London), 2: 1118-19(Oct. 1969).

An asymptotic expression for the cross section for excitation of hydrogen atoms by fast protons to any state ns was obtained. Good agreement with the exact results found for impact energies greater than or equal to 25 keV. (auth) (UK)

3172 COLLISIONS OF Ar^+ IONS WITH Cu ATOMS IN THE VAPOR PHASE. Van Der Weg, W. F.; Bierman, D. J.; Onderdelinden, D. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 44: 161-76(Sept. 15, 1969).

Measurements on the charge states of Ar and Cu ions resulting from collisions of 30- to 90-keV Ar^+ ions with Cu vapor are presented as a function of scattering angle. The results are compared with calculations according to a statistical model for the distribution of inelastic energy loss among the electrons of the collision partners. Expressions for the degree of ionization using a staggered ionization potential model are derived. The treatment is largely based upon Russek's model and may be compared with Everhart's description of the $Ar^+ \rightarrow Ar$ collision. The amount of inelastic energy, according to the model, necessary for the multiple ionization, is compared with earlier measurements. This paper, together with the inelastic energy measurements, constitutes a phenomenological description of the $Ar^+ \rightarrow Cu$ collisions. (auth)

3173 CHARACTERISTIC ENERGY LOSSES OF 30-keV ELECTRONS IN VAPORS OF AROMATIC HYDROCARBONS. Koch, E. E.; Otto, A. (Univ., Munich). Opt. Commun., 1: No. 2, 47-9(May 1969).

Measurements are reported of 30-keV electrons scattered at zero angle in vapors of benzene, naphthalene, anthracene, tetracene, phenanthrene, chrysene, pyrene, and coronene. Comparison with optical absorption measurements and MO calculations leads to the assignment of several losses to $\pi-\pi^*$ single-electron transitions. The interpretation of some losses in the vuv region and at higher energies is still tentative. (auth)

3174 TEST OF A THEORY OF ELASTIC CHARGE POLARIZATION BY COMPARISON WITH THE DATA OF BROMBERG FOR He. Bonham, R. A. (Indiana Univ., Bloomington); Liu, J. W.; Fink, M. J. Chem. Phys., 51: 4162-3(Nov. 1, 1969).

Relativistic partial-wave elastic differential cross sections for electron scattering by He at 500 eV are compared with experimental values obtained by Bromberg [J. Chem. Phys., 50: 3906 (1969)]. Corrections for exchange and charge polarization not included in the original calculations are then calculated. When the corrections are compared with the differences between the experimental values and the calculated partial-wave values, agreement is considered to be good. (A.G.W.)

3175 WKB SOLUTION OF INVERSION PROBLEMS FOR POTENTIAL SCATTERING. Miller, William H. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 51: 3631-8(Nov. 1, 1969).

The construction of a local, not necessarily monotonic, potential is given in the WKB approximation for the two following sets of "input" information: (1) the phase shift as a function of impact parameter (or orbital angular momentum) at one energy; (2) the phase shift as a function of energy for one value of l, plus the eigenvalues of the potential for this same l. It is also shown that in the high-energy WKB approximation (Eikonal approximation) the energy dependence of the total cross section can be inverted to obtain the potential. Procedures for constructing the classical deflection function (or, equivalently, the phase shift as a function of impact parameter) from the observed differential cross section are also discussed. (auth)

3176 EXCITATION OF NITROGEN BY ELECTRONS: THE LYMAN–BIRGE–HOPFIELD SYSTEM OF N_2. Holland, R. F. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 51: 3940-50(Nov. 1, 1969).

The intensity of vacuum ultraviolet emission produced by a beam of electrons in nitrogen was measured to determine the probability of exciting the Lyman–Birge–Hopfield (LBH) bands of N_2. Measurements included spectral scans of the region 1250 to 2150 Å and scans across the electron beam with a photometer sensitive in the range 1230 to 1800 Å. Some 60 spectral features were attributed to LBH bands. Emission in these bands persisted in a glowing region outside the electron beam. At low gas pressure (0.1 μ), relative band intensities are in rough agreement with values calculated by assuming that the Franck–Condon principle applies in excitation and emission. At higher pressure, the intensity was increased by secondary processes, and bands with lower v′ were enhanced relative to other bands. Photometer scans at low pressure yielded a profile of the glow around the beam, which was fairly consistent with a profile calculated by assuming a radiative lifetime of 80 μsec for the parent state of the LBH. Based on the calculated profile and spectrometer and photometer observations, an apparent cross section of $1.1 \pm 0.2 \times 10^{-18}$ cm^2 was obtained for excitation of the LBH system by 900-eV electrons. The dependence on energy of representative bands indicated total LBH cross sections for 100- and 2000-eV electrons of 6.7×10^{-18} and 5.2×10^{-19} cm^2, respectively. (auth)

3177 ABSOLUTE DIFFERENTIAL CROSS SECTIONS OF ELASTICALLY SCATTERED ELECTRONS. II. A POLARIZATION SCATTERING POTENTIAL FOR Hg AT 500, 400, AND 300 eV. Bromberg, J. Philip (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 51: 4117-22(Nov. 1, 1969).

Absolute differential cross sections of electrons elastically scattered by Hg were measured at 500, 400, and 300 eV. It was found that over this energy range, for angles between 2.5° and 20°, the measured cross sections can be accurately described using the Born approximation with a long-range effective potential of the form $V(r) = 4Cb/\pi(r^2 + b^2)^2$, where C and b are constants arising from the intercept and slope, respectively, of plots of $\ln\sigma$ vs ΔP, and where $4Cb/\pi = \alpha/2$, where α is the polarizability of the Hg atom. (auth)

3178 OPTICAL-POTENTIAL APPROACH TO HIGH-ENERGY ELECTRON–ATOM SCATTERING. APPLICATION TO e–He AND e–O COLLISIONS. Janev, R. K. (Inst. of Physics, Belgrade). Fizika (Zagreb), 1: 173-82(July 1, 1969).

Starting from the scattering amplitude in the second Born approximation an optical potential for elastic scattering of electrons on complex atoms is obtained. The proposed optical model gives the possibility of direct determination of the high-energy elastic-scattering cross section in the second Born approximation. General theoretical results are applied to the e–He and e–O collisions. Results of the calculations are compared with the experimental data as well as with the more exact calculations. (auth)

3179 OBSERVED Kβ ENERGY SHIFT IN Cu AND Ni. Richard, Patrick; Morgan, I. L.; Furuta, T.; Burch, D. (Univ. of Texas, Austin). Phys. Rev. Lett., 23: 1009-11(Nov. 3, 1969).

The characteristic Kβ x rays produced by 15.0-MeV oxygen (O^{4+}) ions on Ni are found to shift in the spectrum by 112 ± 15 eV relative to the energies produced by x-ray and proton excitation in Ni. Similarly, in Cu an energy shift of 97 ± 15 eV is observed. The observed shift is possibly due to the larger Kβ energies of the multiply ionized Ni or Cu produced in O^{4+} bombardments as opposed to the singly ionized Cu or Ni Kβ x rays. (auth)

3180 DIPOLE-POLARIZATION POTENTIAL IN H_2–ELECTRON SYSTEM. Hara, Shunsuke (Tokyo Univ.). J. Phys. Soc. Jap., 27: 1262-7(Nov. 1969).

The adiabatic polarization potential in the system of a hydrogen molecule and an electron is calculated by a variation perturbation method in two-center prolate spheroidal coordinates. In this calculation, a 16-term James–Coolidge-type wave function is used for obtaining the dipole contribution to the potential. This is the first detailed calculation of the polarization potential of a diatomic molecule in two-center coordinates. The asymptotic forms of the dipole polarization potential in the direction parallel and perpendicular to the molecular axis are $-5.975/5r^4$ and $-4.359/2r^4$ in atomic units, respectively. The numerators of these asymptotic forms are to be compared with the exact values of the dipole polarizabilities 6.38049 and 4.55769 a.u. obtained by Kotos and Wolniewicz. (auth)

3181 VIBRATIONAL EXCITATION OF CO BY SLOW-ELECTRON COLLISIONS. Itikawa, Yukikazu; Takayanagi, Kazuo (Tokyo Univ.). J. Phys. Soc. Jap., 27: 1293-1300(Nov. 1969).

The cross section for the vibrational excitation $v = 0 \rightarrow 1$ of CO by slow-electron collisions is calculated using the close-coupling method. First, only the dipole interaction is considered to give rise to the vibrational transition and the result is compared with the Born calculation; it is found that the Born approximation gives a rather poor result in the present case. Next, the polarization effect of the molecule is taken into account. The contribution from the polarization term is shown to be comparable to that from the dipole interaction. Finally, the excitation cross section is evaluated by including both the dipole and the polarization interactions, and a comparison is made with experimental data. (auth)

3182 COLLISIONAL TRANSFER OF TRIPLET EXCITATIONS BETWEEN HELIUM ATOMS. Kodaira, Mitsuhiko; Watanabe, Tsutomu (Tokyo Univ.). J. Phys. Soc. Jap., 27: 1301-9 (Nov. 1969).

The cross sections for 2^3S and 2^3P excitation-transfer processes between He atoms are calculated by the perturbed stationary state method. The potential energy curves for $He(1^1S) + He^*(2^3P)$ and $He(1^1S) + He^*(2^3S)$ systems are obtained by the Heitler–London method taking the configuration interaction between them into account. The calculation involves the transfer, the diffusion, and the total elastic cross sections. The results show that the transfer cross section for 2^3P is $15 \sim 23\pi a_0^2$ at thermal energy and larger than that for 2^3S. The transfer cross section for 2^3S does not differ so much from the calculation using rigorous potentials by Kolker and Michels [J. Chem. Phys., 50: 1762(1969)]. (auth)

3183 VIBRATIONAL EXCITATION BY ELECTRON IMPACT NEAR THRESHOLD IN H_2, D_2, N_2, AND CO. Burrow, P. D.; Schulz, G. J. (Yale Univ., New Haven). Phys. Rev.: 187: 97-105(5 Nov 1969).

The trapped-electron method is applied to the measurement of the slopes of the vibrational cross sections near their respective thresholds. Absolute values are obtained by normalization to positive-ion cross sections. The values obtained in H_2 are 43 for $v = 1$, 0.72 for $v = 2$, 0.04 for $v = 3$, and 0.003 for $v = 4$, in units of 10^{-18} cm^2/eV. The values for N_2 are 2.5 for $v = 1$ and about 0.02 for $v = 2$, whereas, the values for CO are much larger, i.e., 120 for $v = 1$ and 2.4 for $v = 2$. Various corrections that are necessary for determining absolute cross sections from trapped-electron data are discussed. The validity of the corrections is studied for the case of the 2^3S excitation function in He. (auth)

3184 DISCRETE DEPOSITION OF ENERGY BY ELECTRONS IN GASES. Peterson, Lennart R. (Univ. of Florida, Gainesville). Phys. Rev.: 187: 105-11(5 Nov 1969).

Much previous work on the energy deposition of electrons in gases has centered on the continuous-slowing-down approximation, the key element being the loss function $-(1/n)dE/dx$. Calculations generally reduce to energy integrals involving cross sections and this loss function. The limits of the continuous approximation are now examined by comparing it over various energy intervals with a method that takes into account the discrete nature of the energy lost in each collision. The calculation at each stage considers how an electron at a particular energy will redistribute itself on average at all lower energies, with the distribution depending on cross sections and transition energies. Results of the present work for He and N_2, and comparisons to the continuous approximation, are given. (auth)

3185 THRESHOLD ELECTRON-IMPACT EXCITATION OF THE 5s ELECTRON IN XENON. Brion, C. E.; Olsen, L. A. R. (Univ. of British Columbia, Vancouver). Phys. Rev.: 187: 111-13(5 Nov 1969).

The threshold electron-impact excitation of the 5s electron in xenon was studied, using electron scavenging by sulfur hexafluoride. Optically forbidden states are preferentially excited. (auth)

3186 EXPERIMENTAL DETERMINATION OF THE CORRELATION EFFECTS IN THE TOTAL DIFFERENTIAL ELECTRON CROSS SECTION. I. Ne. Fink, M.; Bonham, R. A. (Indiana Univ., Bloomington). Phys. Rev.: 187: 114-18(5 Nov 1969).

The relative total differential electron cross section (elastic plus inelastic scattering) for Ne was measured with an accuracy of 0.25%. The experimental data were compared with scattering factors calculated with the first Born approximation using a Hartree–Fock wave function and a configuration-interaction wave function giving 86% of the atomic electronic correlation energy. The comparison is in very good agreement with the recently published first-Born-approximation scattering factors employing this configuration-interaction wave function. The measurements prove that electron diffraction can be a useful experimental tool for studying correlation effects on the scattered intensity with an accuracy of at least 20% in atoms and molecules. (auth)

3187 DE-EXCITATION OF HELIUM 2^1S AND 2^3S ATOMS IN FAST COLLISIONS WITH NORMAL HELIUM ATOMS. Hollstein, M.; Sheridan, J. R.; Peterson, J. R.; Lorents, D. C. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev.: 187: 118-22(5 Nov 1969).

Cross sections for de-excitation of helium 2^1S and 2^3S atoms in collisions of a helium metastable atomic beam with normal helium atoms were measured in the laboratory energy range 150 to 2200 eV. The singlet cross sections are from 20 to 75% larger than the triplet cross sections. Both cross sections were found to obey the general relationship $Q^{\frac{1}{2}} = a - b \ln v$ with an oscillatory structure superimposed upon this monotonic velocity dependence. The magnitudes of the triplet cross sections compare favorably with calculated values of the cross section for the symmetric excitation-transfer reaction between 2^3S and 1^1S atoms. (auth)

3188 ROTATIONAL EXCITATION OF THE (H,H_2) SYSTEM. Tang, K. T. (Pacific Lutheran Univ., Tacoma, Wash.). Phys. Rev.: 187: 122-30(5 Nov 1969).

An analytic two-body potential, consistent with all available data, is presented for the (H,H_2) system. This potential is then used in the calculation of rotational excitation with the distorted-wave Born approximation. As compared with the results of previous studies, the differential cross sections are drastically different, and the total cross sections are smaller by an order of magnitude. This is because the potential used is different from that used previously. (auth)

3189 BORN-WAVE CALCULATION OF ATOM–ATOM INELASTIC CROSS SECTIONS: EXCITATION OF He(1^1S) TO He(N^1L) BY HYDROGEN ATOMS. Levy II, Hiram (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Rev.: 187: 130-5(5 Nov 1969).

Total first Born-wave excitation cross sections are calculated for He(1^1S) + H(1s) → He(2^1S, 3^1S, 4^1S, 5^1S, 2^1P, 3^1P, 4^1P, 3^1D, 4^1D, 5^1D) + H(Σ) over the energy range 1.0 keV to 1.6 MeV. The highly accurate numerical generalized oscillator strengths of Kim and Inokuti and of Bell, Kennedy, and Kingston are used to describe the projectile excitations. The complete summation over target final states is performed both exactly by use of the analytic generalized oscillator strengths and approximately by use of the closure relationship. The results are compared with available experimental data and previous calculations, and the discrepancies are discussed. The differences between results calculated by summation over all the target final states and those calculated by the assumption of closure are also discussed. (auth)

3190 MULTISTATE IMPACT-PARAMETER CALCULATION OF ATOM–ATOM EXCITATION CROSS SECTIONS: EXCITATION OF H(1s) BY He(1^1S). Levy II, Hiram (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Rev.: 187: 136-42(5 Nov 1969).

A general method of calculating the time-dependent matrix elements needed for multistate impact-parameter calculations of atom–atom inelastic cross sections is presented and applied to the collision processes H(1s) + He(1^1S) → H($2s,2p_m$) + He(1^1S). Cross sections calculated in the distorted-Born, two-state, and four-state impact-parameter approximations over the incident energy range $1.0 \text{ keV} \leq E \leq 200.0 \text{ keV}$ are compared with previous experimental results and first Born-wave calculations. The first Born-wave calculations are in better agreement with the experimental measurements than are the distorted-Born, two-state, and four-state impact-parameter calculations, but the fact that the corrections to the first Born become significant for $v \leq 1.0$ a.u. suggests that the good agreement may be accidental. Polarization fractions are calculated, and good agreement is shown with experiment for $v \leq 0.8$ a.u. (auth)

3191 CHARGE-TRANSFER CROSS SECTIONS FOR H^+, Li^+, AND Na^+ ON N_2. Lockwood, Grant J. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev.: 187: 161-6(5 Nov 1969).

Measurements of the total cross section for charge transfer σ_{10} of H^+, Li^+, and Na^+ on N_2 are reported here in the energy range of 25 to 100 keV. The method used was direct detection of fast neutral particles formed in single charge-transfer collisions. Data for H^+ on N_2 are in excellent agreement with previously published results with σ_{10} increasing with decreasing energy, reaching a value of 1.55×10^{-15} cm^2/molecule at 5 keV. From data for Li^+ and Na^+ on N_2, σ_{10} is observed to increase with increasing energy. The cross section for Na^+ has a maximum of 1.1×10^{-16} cm^2/molecule at about 50 keV, while the cross section for Li^+ is still increasing at 100 keV, although an irregularity is observed at approximately 30 keV. (auth)

3192 THEORETICAL INVESTIGATION OF COMPLEX POTENTIALS FOR ATOMIC COLLISIONS. I. NUMERICAL SOLUTION OF MODEL (H^-,H) COLLISIONS. Mizuno, Junya; Chen, Joseph C. Y. (Univ. of California, San Diego, La Jolla). Phys. Rev.: 187: 167-92(5 Nov 1969).

A set of coupled equations for rearrangement collisions involving processes such as scattering, electron transfer ($A^- + B \rightarrow A + B^-$), collisional detachment ($A^- + B \rightarrow A + B + e$), and associative detachment ($A^- + B \rightarrow AB + e$) is solved numerically for the (H^-,H) collision system at low energies. In this calculation, the interaction potential between the ground states of H and H^- is approximated by a set of local complex potentials. The energy dependence and scattering-angle dependence of the electron-detachment and electron-transfer probabilities, and of differential cross sections for scattering, electron transfer, and detachment processes, are calculated. A detailed analysis of the interference structures in the various differential cross sections is made for the diffraction and multipath scatterings, and for the gerade–ungerade and nuclear symmetry interferences. The effect of damping due to the imaginary parts of the complex potentials and the effect of isotope substitutions are investigated. To examine the sensitivity of the calculated results to the potentials adopted, the calculations are carried out for several sets of such complex potentials. Important differences, which may provide useful information for further investigations, are found for different sets of potentials. (auth)

3193 APPLICATION OF THE PSEUDOPOTENTIAL METHOD TO ATOMIC SCATTERING. Callaway, J.; Laghos, P. S. (Louisiana State Univ., Baton Rouge). Phys. Rev.: 187: 192-200(5 Nov 1969).

The empirical pseudopotential method is discussed and applied to a calculation of the spin-exchange cross section in collisions of Na and Cs atoms. The difference between potential energy curves for the lowest singlet and triplet states of the Na–Cs system is calculated by the Heitler–London method, using a

Hamiltonian in which the effects of tightly bound electrons are replaced by a pseudopotential. Wave functions for the free atoms are found by numerical integration using the pseudopotential, and agree well with the exact valence-electron functions at large distances. The scattering phase shifts are calculated in the WKB approximation, and the cross section computed from them is averaged over a Boltzmann distribution of relative velocities. At a temperature of 500°K, the averaged reduced spin-exchange cross section is 1.5×10^{-14} cm^2. (auth)

3194 COLLISION SPECTROSCOPY. II. INELASTIC SCATTERING OF He^+ BY Ne. Coffey, Dewitt Jr.; Lorents, D. C.; Smith, F. T. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev.: 187: 201-20(5 Nov 1969).

The inelastic scattering of He^+ by Ne has been studied as a function of angle θ and energy loss ΔE over the range of barycentric energies E from 22 to 500 eV. Many levels of Ne are excited, including autoionizing ones, and excited He^+ is also seen. Excitation of the $2p^5 3s$ configuration of Ne at about 16.8 eV could be resolved uniquely, and was studied in detail. The process does not occur in forward scattering, but only outside a threshold obeying the rule $\tau_c = (E\theta)_c \cong 1035$ eV deg, typical of a curve-crossing interaction. It shows pronounced Stueckelberg interference oscillations, arising from the existence of two semiclassical trajectories inside the crossing point at r_c, with the property that the product of the wave number k and the angular spacing $\Delta\theta$ between peaks is substantially constant, i.e., $\Delta b = 2\pi/k\Delta\theta = 0.44$ a.u. These and other properties suffice to show that the upper state is attractive and to identify the transition with the outermost crossing that perturbs the elastic scattering of He^+ by Ne, which was earlier shown to be located at $r_c \cong 1.9$ a.u. and at an energy of $V_c \cong 13.5$ eV. The behavior of the reduced cross section $\rho = \theta \sin\theta\sigma(\theta,E)$ at the first Stueckelberg peak shows that the transition probability peaks at an energy of about 25 eV, i.e., when the velocity at the crossing point is about 2.6×10^8 cm/sec. From this, the transition matrix element at the crossing is deduced by Landau–Zener theory to be roughly $H_{12}(r_c) \lesssim 1$ eV. At higher energies the maximum height of the first Stueckelberg peak shows a general falloff as $\rho_0 E = 3.2 \times 10^{-16}$ cm^2 eV, as well as a slow oscillation whose peaks are evenly spaced in reciprocal velocity with a characteristic spacing constant $v_s = 8.8 \times 10^8$ cm/sec. This slow oscillation is also seen as an amplitude modulation of the whole pattern of Stueckelberg oscillations, and it is tentatively ascribed to a second mode of dissociation of the excited state produced in the crossing, yielding Ne^+ and He(1s2s), which are not detected in our experiments; the probability of producing one or the other set of products presumably depends on the time spent in passing through an interaction region, and thus on the velocity. Above 250 eV another excitation process appears with a threshold at $\tau_x \cong 5000$ eV deg, arising from a crossing at $r_x \cong 1.23$ a.u. with a second state dissociating to the same products. Its transition matrix element is shown to be roughly $H_{13}(r_x) \lesssim 3$ eV. Approximate potential curves are deduced for three of the low-lying $^2\Sigma$ states of $HeNe^+$ and compared with calculations by Michels. It is shown that the available crossings may explain the measured total charge-transfer cross sections measured by Stedeford and Hasted at energies below 1 or 2 keV, but not the magnitudes near the maximum near 10 keV. (auth)

3195 SOME REMARKS ON PROJECTION OPERATORS AND THEORIES OF DISSOCIATIVE ATTACHMENT. Shipsey, Edward J. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev.: 187: 394-6(5 Nov 1969).

A difficulty recently pointed out in O'Malley's theory for dissociative attachment in the reaction $AB + e \rightarrow A + B^-$ can be removed by employing the truncated diagonalization method. (auth)

Atomic Theory

3196 (SC-RR-69-137) AUGER TRANSITION RATES INVOLVING PARTIALLY FILLED SHELLS. McGuire, Eugene J. (Sandia Labs., Albuquerque, N. Mex.). Aug. 1969. 81p. Dep. CFSTI.

Expressions for Auger transition rates in L–S coupling are determined. The rates are found for initial s, p, or d holes in an inner shell. The treatment is extended to cases where either or both of the Auger electrons come from a partially filled shell. While the expressions for transitions between specific terms of two configurations are complex, when one sums over initial and final terms the expressions are simplified. These latter quantities are used in fluorescence yield determination. (auth)

3197 PROGRAM FOR CALCULATING ATOMIC STRUCTURES. Eissner, W.; Nussbaumer, H. (University Coll., London). J. Phys. B(London), 2: 1028-43(Oct. 1969).

A method for calculating atomic structures, suitable for the electronic computer, is outlined; the method allows for configuration interaction in a very general way. It is based on the expansion of wave functions in terms of Slater states. All relativistic interactions are disregarded and an SL coupling scheme is used. The number of terms SL considered is that resulting from all configurations included; the configurations are the only input apart from the nuclear charge Z. The energy matrix is expressed in terms of radial integrals with purely algebraic coefficients and a scheme is described for computing these coefficients. The integrals are evaluated using radial wave functions calculated in a scaled Thomas–Fermi potential. Numerical examples for Na I and Mg I isoelectronic sequences are given. Layzer (1959) pointed out the importance of configuration interaction within a complex, and his predictions for stages of high ionization are confirmed. It is shown that, for stages of medium or low ionization, interaction with configurations belonging to other complexes can become important. (auth) (UK)

3198 ATOMIC PHYSICS. Shpol'skii, E. V. London, Iliffe Books Ltd., 1969. 645p. 80s.

Translated from Russian text by A. Tybulewicz.

The following topics are discussed: charge and mass of the electron; atoms and isotopes; nuclear structure of the atom; x rays and their application to determination of atomic constants; structure of the atom and classical physics; radiation of a perfect black body and the hypothesis of energy quanta; energy levels and atoms; spectral series and energy levels of the H atom; light quanta; waves and particles; Schroedinger equations. (UK)

3199 ON THE USE OF PSEUDOPOTENTIALS IN THE QUANTUM THEORY OF ATOMS AND MOLECULES. Weeks, J. D.; Hazi, A.; Rice, S. A. (Univ. of Chicago). Advan. Chem. Phys., 16: 283-342(1969).

Following the introduction to the subject and some general remarks the following topics are discussed: The generalized Phillips–Kleinman pseudopotential; applications of the one-electron pseudopotential theory (scattering of an electron from a helium atom in the limit of zero incident energy; atomic Rydberg states in the one-electron approximation); general one-electron model potentials; calculation of the energies of molecular Rydberg states using model potentials; model pseudopotentials and model potentials suggested from pseudopotential theory; Rydberg states of model pseudopotentials for Be^+ and Mg^+; two-electron problems and the use of model potentials; application of the two-electron model potential to study of the electronic energy of Be and Mg (general considerations; beryllium results; magnesium results); further approximations of two-electron model potential equations. 46 references. (UK)

3200 RELATIVISTIC THOMAS–FERMI THEORY. Tomishima, Yasuo (Okayama Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 437-47(Sept. 1969).

By introducing a modified Weizsäcker correction, a relativistic Thomas–Fermi theory is developed without any divergence difficulties. The electron density distribution and the total energy are obtained for several free neutral atoms and positive ions. (auth)

3201 REDUCED SPIN–SPIN MATRIX ELEMENTS FOR f^4. Armstrong, Lloyd Jr. (Johns Hopkins Univ., Baltimore); Taylor, Lyle H. J. Chem. Phys., 51: 3789-94(Nov. 1, 1969).

Reduced matrix elements for all possible two-body Hermitian operators with spin and orbital rank of two are evaluated for the f^4 configuration. Most of the vanishing matrix elements can be explained by simple group-theoretical selection rules and some can be explained by vanishing coupling coefficients. However, 16 zeros still remain to be explained. (auth)

3202 STATIONARY PROPERTIES OF APPROXIMATE WAVE FUNCTIONS. Ruffa, A. R. (Naval Research Lab., Washington, D. C.). Can. J. Phys., 47: 2355-61(Nov. 1, 1969).

The accuracy of quantum mechanical wave functions is examined in terms of certain stationary properties. The most elementary of these, namely that displayed by the class of wave functions that yields a stationary value for the total energy of the system, is demonstrated to necessarily require few other stationary properties, and none of these appear to be particularly useful. However, the class of wave functions that yields both stationary energies and charge densities has very important stationary properties. A theorem is proven, which states that any wave function in this class yields a stationary expectation value for any operator that can be expressed as a sum of one-particle operators. Since the Hartree–Fock wave function is known to possess these same stationary properties, this theorem demonstrates that the Hartree–Fock wave function is one of the infinitely many wave functions of the class. Methods for generating other wave functions in this class by modifying the Hartree–Fock wave function without changing its

stationary properties are applied to the calculation of wave functions for the helium atom. (auth)

Cosmic Radiation

Refer also to abstracts 2445, 2447, 3058, 3118, 3131, 3513, 3544, 3573, 3574, 3600, and 3607.

3203 (CEA-R-3815) SOME WAYS FOR THE INVESTIGATION OF THE SOLAR MODULATION OF COSMIC ELECTRONS. Mercier, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1969. 37p. (In French). Dep. CFSTI (U. S. Sales Only).

Solar modulation of cosmic electrons was investigated as follows: (1) by comparing the calculated intensity with the measured intensity of positrons, one can evaluate the solar modulation of positrons, hence the modulation of electrons, since the modulation of electrons is probably the same as that for positrons; (2) by comparing the electron spectrum in interstellar space needed to explain the galactic background radio emission with that observed near the Earth, one can deduce information about the modulation of electrons; and (3) modulation through the observation of its variations during the solar cycle. These different ways lead to compatible results. In spite of the fact that the precision of the experimental data is poor, the modulation can be represented by: (a) a constant, or a form in exp (-K /Roβ) under the rigidity Ro ≃ 0.5 BV, and (b) a form in exp (-K/R) or exp (-K/Rβ) above this rigidity. In addition, the investigation of both electrons and protons shows that the diffusion-convection theory is inadequate to explain all the features of the solar modulation. (auth)

3204 MEASUREMENT OF THE PRIMARY COSMIC-RAY PROTON SPECTRUM BETWEEN 40 AND 400 GeV. Schmidt, W. K. H. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.); Pinkau, K.; Pollvogt, U.; Huggett, R. W. Phys. Rev., 184: 1279-82(Aug. 25, 1969).

Equipment consisting of an ionization spectrometer and spark chambers was exposed to primary cosmic rays in a balloon flight which allowed a data collection time of 14.3 h at an altitude of 5.7 g/cm^2. The purpose of this experiment was to study the flux, composition, possible time variations, and nuclear interaction properties of cosmic rays at energies between 40 and 400 GeV. The apparatus was also exposed to 10-, 20.5-, and 28-GeV/c protons at the Brookhaven AGS in order to study the spectrometer response at three known energies and to be able to extrapolate this response to higher energies. The integral energy spectrum of primary cosmic-ray protons between 40 and 400 GeV was found to be $n(\geq E_0) = (0.91^{+0.3}_{-0.2})E_0^{-1.7\pm0.1}$ (E in GeV). The corresponding intensity is a factor of 2 lower than that obtained from the Proton I and II satellite experiments. (auth)

3205 LOW-ENERGY COSMIC-RAY SPECTRUM. Hjellming, R. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett., 4: 81-4(Sept. 1969).

The cosmic-ray spectrum for energies less than 30 MeV/nucleon is determined from a knowledge of the ionization rate per hydrogen atom produced by low-energy cosmic rays in the interstellar medium. It is suggested that a peak in the cosmic-ray intensity between roughly 0.2 and 3 MeV/nucleon may be identified with the high-energy portion of particle emission from stars. (auth)

3206 ORIGIN OF THE X-RAY BACKGROUND. Longair, M. S. (Lebedev Inst. of Physics, Moscow); Sunyaev, R. A. Astrophys. Lett., 4: 65-70(Sept. 1969).

A source model is described in which it is possible to account for the details of the observed x-ray background spectrum for energies $\epsilon > 100$ eV. As a result of inverse Compton scattering, relativistic electrons originating in the nuclei of intense sources of infrared radiation produce (i) hard x rays by scattering the infrared quanta in the nuclei and (ii) soft x rays by scattering photons of the relict radiation once the electrons escape into the intergalactic medium. (auth)

3207 RECENT ADVANCES IN THE STUDY OF FOSSIL TRACKS IN METEORITES DUE TO HEAVY NUCLEI OF THE COSMIC RADIATION. Lal, D. (Tata Inst. of Fundamental Research, Bombay). Space Sci. Rev., 9: 623-50(Aug. 1969).

The present state of the science and knowledge emerging from the observations of fossil tracks in meteorites is discussed. Recently, several technological improvements have been made that allow a precise study of the fossil tracks, making it possible to treat the meteoritic crystals as ideal detectors of $Z > 22$ elements of cosmic radiation. The various types of fossil-track studies carried out to date and the results thereof are described in some detail. (W.D.M.)

3208 LATERAL DISTRIBUTION OF MUONS IN LARGE AIR SHOWERS. THEORETICAL CALCULATIONS AND COMPARISON WITH EXPERIMENT. Capdevielle, Jean-Noel; Dupuy, Jean; Cachon, Andre (Observatoire du Pic du Midi, Bagneres-de-Bigorre, France). Compt. Rend., Ser. B; 269: 438-41(8 Sep 1969). (In French).

The reconstruction by the calculation of large air showers of cosmic rays the primary energy of which is of the order of 10^{17} eV allows, by comparison with the experimental results on the lateral distribution of muons at sea level, the specification of high-energy nuclear interactions (notably the multiplicity and transverse momentum). (tr-auth)

3209 EFFECTS OF STELLAR AND BLACK-BODY RADIATION ON THE SPECTRA OF PRIMARY NUCLEI. Castagnoli, Carlo; Navarra, Gianni; Penengo, Piero. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 46: 40-4(Jan. 1969). (In Italian).

The energy spectrum of the primary nuclei of the cosmic radiation was calculated by examining their collisions against the photons of stellar light and of the 3°K blackbody radiation. The effect was studied in the energy range both below and above the pion production threshold. The results obtained on the breakdown of the He, C, and Fe spectra were compared with the latest results on the proton spectrum. (auth)

3210 MODULATION OF GALACTIC COSMIC RAYS AT MINIMUM SOLAR ACTIVITY ACCORDING TO THE MEASUREMENTS MADE BY SATELLITES. Vernov, S. N.; Okhlopkov, V. P.; Charakhch'yan, T. N. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1809-13(Nov. 1968). (In Russian).

Cosmic-ray intensity near the magnetosphere boundary was measured by Elektron-2 and Elektron-4 satellites during Feb. 1964 and Feb. 1965. The observed Forbush decrease effects were accompanied by geomagnetic perturbations which were correlated with the quasi-stationary sectors of the interplanetary field discovered previously. Twenty-two Forbush decreases were analyzed and graphical data obtained with various detectors are given. It was observed that for certain Forbush decreases the amplitude variations of α particles considerably exceeded the amplitude variations of the proton flux. With the variation spectrum index $\gamma = 0.2$ to 0.7, the anticipated ratio of the amplitude variations, of proton number ($E_{kin} \gtrsim 45$ MeV) and the number of α particles ($E_{kin} \gtrsim 600$ MeV) within the limits of 1.2 to 1.7 for the Forbush decreases of Feb. 12, 1964 and Feb. 6, 1965 was $(\Delta n/n)_p/(\Delta n/n)_\alpha = 0.62 \pm 0.12$ and 0.61 ± 0.05, respectively. (R.V.J.)

3211 HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION. Kurnosova, L. V.; Razorenov, L. A.; Logachev, V. I.; Fradkin, M. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1814-17 (Nov. 1968). (In Russian).

Measurements were made of the relative flux and composition of a group of super-heavy nuclei. The charge of the nuclei determined with the order of error of ±4% was 39, 40, 42, 47, 51, 55, 67, 89, and 92. The ratio of the super-heavy nuclei with $Z \geq 40$ to the very heavy nuclei $Z \geq 20$ was 4×10^{-5} and for flux of nuclei with $Z \geq 48$ to $Z \geq 20$ nuclei it was 2.5×10^{-6}. Detailed analysis of 400 tracks in the vicinity of the nine super-heavy nuclei did not reveal any belonging to the super-heavy nuclei, thus, the evaluated ratio of nuclei with $Z \geq 32$ to the nuclei of the iron group was $SH/VH < 2 \times 10^{-3}$. (R.V.J.)

3212 NEGATIVE MUONS AND THE ISOTOPIC COMPOSITION OF THE RARE GASES IN THE EARTH'S ATMOSPHERE. Jeffery, P. M. (Univ. of Chicago); Hagan, P. J. Nature (London), 223: 1253(Sept. 20, 1969).

Attention is drawn to the possible influence which negative muons may have had on the isotopic composition of the rare gases now present in the earth's atmosphere and crust, and in meteorites. The specific reaction to be considered is of the form negative muon + target nuclide (A,Z) → rare gas nuclide (A,Z-1) → rare gas nuclide (A-X, Z-1) + X neutrons + neutrino where X is the neutron multiplicity of the target nuclide. The present muon flux of 10^{-2} cm^{-2} s^{-1}, if maintained over 4.5×10^9 years, is insufficient by a factor of ~10^6 to produce the isotopic differences observed between the rare gases in the terrestrial atmosphere and those found in primitive meteorites, and there is no evidence that the muon flux was higher in the past. It is conceivable, however, that a higher muon flux prevailed at an early stage in the primitive solar nebula. Negative muons, reacting with alkali element target nuclides, will produce rare gases the isotopic abundance patterns of which will depend critically on the neutron multiplicities of the individual isotopes of each target element, and some of the isotopes produced in greatest yield are those which seem necessary to explain the observed isotopic differences between the noble gases found in the terrestrial atmosphere and

in meteorites. The target and product nuclides which have a special significance in relation to rare gas studies are listed. Two-stage processes involving negative muon decay followed by positron decay or electron capture may also be relevant. Neon is considered in detail as a specific example of these hypotheses. It seems possible that up to 30% of the ^{22}Ne in the earth's atmosphere has resulted from the capture of negative muons by ^{22}Ne, and atmospheric neon would now be considered a mixture of solar type Ne with muon-produced Ne in suitable proportions. A critical factor is the quantity of target nuclide that was available for the muon capture process. The addition of some 30% to the ^{22}Ne atmospheric abundance implies only about 1% addition to the ^{132}Xe abundance. The cases of Kr and Xe are briefly considered. (UK)

Direct Energy Conversion

Refer also to abstract 3407.

3213 (N-69-33447) DEVELOPMENT OF THERMIONIC CONVERTERS. Quarterly Progress Report. Jacobson, Dean; Hamerdinger, Randy (Electro-Optical Systems, Inc., Pasadena, Calif.). July 15, 1969. Contracts NAS7-100; JPL-952255. 17p. (NASA-CR-103835; EOS-4018-Q-2). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

A program to design and develop low-power, high-efficiency thermionic converters of cylindrical geometry is reported (see also N-69-35431). Seven converters and a bombardment heater unit are deliverable items per the contract statement of work. The converter development is to proceed in an iterative fashion whereby each converter design is reviewed separately and approved before fabrication. Subsequent performance data are reviewed separately, and will formulate the basis for redesign. (auth) (STAR)

3214 (N-69-35431) DEVELOPMENT OF THERMIONIC CONVERTERS. Quarterly Progress Report. Jacobson, Dean (Electro-Optical Systems, Inc., Pasadena, Calif.). Apr. 21, 1969. Contracts NAS7-100; JPL-952255. 25p. (NASA-CR-104102; EOS-4018-Q-1). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Initial progress is reported in a program to design and develop low-power, high-efficiency, thermionic converters of cylindrical geometry. The converters will be capable of being integrated to form a modular power supply. The central philosophy of this approach is to increase the reliability of thermionic space power supplies by redundancy of the basic component. (auth) (STAR)

3215 (N-69-35512) DESIGN AND FABRICATION OF ADVANCED THERMIONIC CONVERTERS. (Thermo Electron Corp., Waltham, Mass.). Nov. 1968. Contracts NAS7-100; JPL-951263. 408p. (NASA-CR-105322; TE-4055-65-69). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Task I centered on the iterative construction of ten engineering models of a solar energy thermionic converter, and their main features are described. In the last three models, the collector-radiator structure of the previous models was replaced by a heat pipe. At the culmination of the effort, the converter with a heat pipe structure had achieved close to a 70% reduction in weight; however, its performance was the same as that of typical converters with rhenium electrodes, and it did not reach the goal of 20 watts/cm^2 at 0.8 volt, 1700°C. Task II involved a generator flux analysis to determine the best number of converters to match the converter heat-requirements to the available solar energy, the optimum cavity aperture size, the required adjustments of surface emissivity and absorptivity values to insure even flux distribution, and the effects of changes in emitter temperature and heat input on flux distribution within the generator. Based on this analysis, a 16-converter generator, using converters with heat pipe collector-radiators, was designed in detail. (auth) (STAR)

3216 (N-69-35689) CHARACTERISTICS OF A THERMIONIC CONVERTER WITH A FLUORIDE VAPOR DEPOSITED TUNGSTEN EMITTER ETCHED TO PREFERENTIALLY EXPOSE THE 110 CRYSTAL PLANES. Wilson, V. C.; Lawrence, J. (General Electric Co., Schenectady, N. Y.). Aug. 1969. Contract NAS3-8511. 117p. (NASA-CR-1381; GEST-2107). CFSTI.

A variable-spaced planar thermionic converter was built with a tungsten emitter, a niobium collector, and a niobium guard ring. The tungsten emitting surface was a 0.020-inch-thick layer of fluoride-vapor deposited tungsten. X-ray analysis and etch-pit studies showed this surface was oriented with a (100) plane parallel to the bulk surface. The surface was etched to expose the (110) planes which are inclined 45° to the (100) planes. The surface was then a mass of peaks, ridges and valleys several microns in depth, and had an exposed area about 40% greater than the plane surface. The initial output performance of this surface at low cesium pressures and also at large spacings was better than unetched (100) tungsten. The most output was obtained at 10 mils spacing or more for emitter temperatures from 1700 to 2000°K. Operation for 21.8 hours at 2155°K reduced the sharpness of the points and ridges and the output performance decreased, particularly at larger spacings. (STAR) (auth)

3217 (N-69-35732) ANALYTICAL AND EXPERIMENTAL STUDIES OF MHD GENERATOR CATHODES EMITTING IN A "SPOT" MODE. Nichols, Lester D.; Mantenieks, Maris A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1969. (NASA-TN-D-5414). CFSTI.

The sheath current-voltage characteristics for a plane cathode emitting current from a thermionic arc spot are derived. The derivation is based upon the requirement of energy conservation at the cathode spot and also in an ionization region adjacent to the spot. The results for given gas conditions and electrode work function predict a sheath voltage which decreases with both increasing current for a fixed undisturbed (i.e., far from the spot) cathode temperature, and increasing disturbed cathode temperature at a fixed current. Experimental data are shown which support the conclusions predicted by the model. (auth) (STAR)

3218 (TEE-3874-6) THERMAL FLUX IN A RESEARCH PARAMETRIC CONVERTER. Lieb, D. (Thermo Electron Corp., Waltham, Mass.). June 30, 1969. Contract AT(30-1)-3874. 29p. (TE-4086-32-70). Dep. CFSTI.

The research guard-ring parametric converter was used to collect geometry-independent data on the performance of thermionic converters. Corrections to the surface temperature are derived, and excellent agreement between the dynamic sweep and static data is found. Results from heat balance tests indicate a preliminary value of 2.1 watts/A for the electron heating of the collector. The electron heating is proportional to the collector current over a wide range in the power-producing region. (D.L.C.)

3219 ON THE PHASE BALANCE OF INDUCTIVE THREE-PHASE MHD CONVERTERS WITH OPEN MAGNETIC CIRCUIT AND LOW MAGNETIC REYNOLDS NUMBERS. Schulz, Tilo. Wiss. Ber. AEG-Telefunken, 42: No. 1, 57-64(1969). (In German).

In MHD converters the finite length of the stator gives rise to the so-called longitudinal end effect. On weak-coupled inductive converters (i.e., with low magnetic Reynolds numbers) the longitudinal end effects occur less as losses but act rather more on the balance of the polyphase system due to unequal magnetization and flux linkage. With converter development tending towards a small number of poles, these effects will become more and more noticeable unless preventative measures are taken in good time. A graphic-analytical method is introduced, which allows rapid estimation of the magnetization and phase balance. The fundamental point is the determination of the elements of a linkage matrix. First of all this is undertaken for the so-called nonstepped winding and the stepped winding in graphical manner. For the nonstepped winding the unipolar flux must be known. Its prediction is possible by a field pattern analysis for example, if it occurs as stray flux. In practice it is more convenient to measure the unipolar flux or the various linkage elements direct on models. The experiments described were performed on two linear models, each comprising two flat stator halves with adjustable air gap. Good agreement was found between calculation and experiment: a slight mutual rotation of the unbalanced current systems is attributable to neglection of the ohmic resistances. In addition a stator was examined with a lower number of poles and improved non-stepped winding, with which better balance of its current systems is obtained by considerably reducing the unipolar flux. This type of winding is thus very suitable for MHD converters with low magnetic Reynolds numbers. (auth)

3220 AEROSPACE RESEARCH AND DEVELOPMENT IN THE U. S. GOVERNMENT. 6. PROPULSION. Parker, M. E. Space/Aeronaut., 52: 121-6(July 1969).

Advances and future prospects in the use of chemical, nuclear, electric, and MHD rocket propulsion are reviewed. With nuclear and electric rockets velocities are limited only by the ability of the construction materials to withstand intense heat and by their weight. Even within these limitations, nuclear and electric rockets can produce exhaust velocities and specific impulses far in excess of those of chemical rockets. The demonstrated performance range extends from about 800 sec for solid-core nuclear rockets to 10,000 sec for ion and magnetoplasmadynamic engines. Power runs of the NASA XE nuclear ground test engine have started. The engine is being tested at various thrusts up to the design level of 50,000 lb, with the reactor operating at power levels of up to 1100 MW(t). The chamber temperature will be about 3600°F. The XE

tests are designed to provide a technology base for the 75,000-lb-thrust Nerva 1 nuclear rocket, expected to be in operation in the late '70s. Nerva, using a solid core, is a first-generation nuclear rocket. The technology needed for more advanced nuclear engines with liquid or gas cores is progressing. While Nerva is limited to a specific impulse of about 800 sec, gaseous nuclear rockets potentially offer 1500 to 3000 sec. In electromagnetic thrusters, the working fluid is ionized to a plasma state and then accelerated to high velocity by electromagnetic fields. A special class, the magnetoplasmadynamic (MPD) thruster, holds considerable promise. Typical specific impulse levels approach 6500 sec. The MPD thruster is simple: a cylindrical cathode with a conical tip and a concentric convergent–divergent nozzle-shaped anode. A low voltage (less that 100 V) is applied across the electrodes. (BBB)

3221 DEVELOPMENT PROSPECTS IN ENERGY CONVERSION. Contzen, J. P. pp 427-53 of Electronic Structures in Solids. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969.

From 2nd Chania Conference, Chania, Greece. See CONF-680633.

Some of the most important conversion processes developed during the last two decades to satisfy the growing needs of electrical power generation on board space vehicles are described. The impact of these initially space-oriented techniques in the terrestrial field is underlined. The following systems are reviewed: photovoltaic cells; radiovoltaic, radiophotovoltaic, and thermophotovoltaic cells; α and β cells; thermoelectric and thermionic systems; and magnetohydrodynamic and electrofluid-dynamic systems. These systems are examined from the point of view of their current state-of-the-art, their development prospects in relation to different types of primary sources, nuclear, solar, chemical and their respective application areas with regard to the power range and the nature of the environment (land, space, sea, and undersea). (auth)

3222 STUDIES ON IRRADIATED MOLYBDENUM EMITTERS FILLED WITH URANIUM DIOXIDE. Winkenback, Herbert; Heidtmann, Uwe. BBC-Nachr., No. 1201/S, 10-16(1967). (In German).

In the development of nuclear-heated converters, two reactor studies were made in which Mo emitters filled with UO_2 were irradiated at 2000°K. In the first series (200 hr of operation time) powdered UO_2 was used as the fuel and in the second (1250 hrs of operation time) Mo-coated particles were the fuel. The Mo emitters are vacuum-tight during the operation period. From radiochemical analysis of the emitter surface and of the inner side of the graphite shell it was shown that no fuel diffused through the emitter wall. With the help of γ spectroscopy no long-lived fission products could be detected on the emitter surface. The powdered UO_2 was compressed by condensation on the walls of the fuel drillings. The Mo cladding of the coated particles was destroyed for the most part under the operational conditions. Chemical noncompatibility between UO_2 and Mo was not established on the basis of the photomicrographs. (tr-auth)

3223 MEDIUM TEMPERATURE THERMOELECTRIC GENERATORS. Alais, M. Onde Elect., 49: 810-16(July-Aug. 1969). (In French).

Thermoelectric generators heated by radioisotopes are presented with particular reference to their output, that is to say, in relation to their cost. The interest of equipment operating at medium temperature is emphasized in the case where the source of heat is of the order of a hundred or a few hundred watts. In support of this reasoning, the Gisete 4 apparatus is described and the measured output values given. In conclusion, particulars are provided of the Gisete 5, a 12-watt generator intended for operation under the sea. (auth)

3224 GENERATION OF IONS IN HIGH-PRESSURE HIGH-VELOCITY GAS STREAM. Von Ohain, Hans J. P.; Wattendorf, Frank L.; Lawson, Maurice O. (to Secretary of the Air Force). U. S. Patent 3,439,197. Apr. 15, 1969. Filed Feb. 16, 1967.

In electrofluid-dynamic power conversion apparatus, limits of pressure and density of the ion transport gas are reached where the desirable corona discharge for generating ions breaks down into a spark or plasma type discharge. To avoid this condition, the gas duct is constructed to include an electrically conducting expansion nozzle, charged to a high electrical potential and also serving as an attractor electrode. A corona-generating electrode is positioned adjacent to the throat of the expansion nozzle and is heated to a high temperature. In the boundary layer in the immediate vicinity of the corona electrode, due to the high temperature, there exists a zone of relatively low gas density and correspondingly low breakdown field strength. An abundant stream of unipolar ions can then be pulled into the gas stream from the heated corona electrode by the attractor electrode potential and be swept downstream in the jet discharge of the expansion nozzle. (auth)

Fluid Physics

Refer also to abstract 2347.

3225 VISCOUS FLUID MOTION EXTERIOR TO A ROTATING SPHERE IN THE PRESENCE OF A TOROIDAL MAGNETIC FIELD. Ranger, K. B. (Univ. of Toronto). Phys. Fluids, 12: 2442-4 (Nov. 1969).

For Alfvén number unity, an exact solution is found for the steady rotation of a magnetized sphere in a viscous conducting fluid. (auth)

3226 CIRCULAR CHANNEL MAGNETOHYDRODYNAMIC EXPERIMENTS IN A TRANSVERSE MAGNETIC FIELD. Loeffler, A. L. Jr.; Maciulaitis, A.; Hoff, M. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Phys. Fluids, 12: 2445-7 (Nov. 1969).

Experimental static pressure distributions and velocity profiles are reported for mercury flow through circular pipes in a transverse magnetic field. Both laminar and turbulent flows were investigated. (auth)

3227 PROPAGATION OF SHOCK WAVES IN INHOMOGENEOUS GAS: OBLIQUE MAGNETOHYDRODYNAMIC SHOCK. Amenomori, Michihiro (Hirosaki Univ., Aomori, Japan). Sci. Rep. Hirosaki Univ., 15: No. 12, 6-13(Dec. 1968).

The generalized Chisnell method was applied to the propagation of magnetohydrodynamic shock waves in inhomogeneous medium, retaining parallelism with the hydrodynamic shock propagation as far as possible. In this method, the medium was regarded as a stack of layers separated by an elementary surface of contact discontinuity, each of the layers having constant density and pressure. Changes of some quantities characterizing the shock wave were examined across one of the layers. The so-called Hoffmann–Teller system of reference was adapted to each of shock fronts participating in the problem, and a shock relation was deduced. The number of waves interacting with the layer was determined by the number of boundary conditions. Changes of parameters in propagation were numerically calculated, and the restraining effect of the magnetic field was shown. The larger angle the magnetic field makes with the layer, the slower is the growth of the shock strength. Results of the numerical calculation were illustrated to show this effect. (NSA of Japan)

3228 A NOTE ON SHALLOW-LIQUID MAGNETOHYDRODYNAMIC DISTURBANCES. Baral, M. C. (Tripura Engineering Coll., Agartale, India). Indian J. Theor. Phys., 17: 13-16 (Mar. 1969).

An attempt is made to determine the magnetohydrodynamic disturbances in a shallow-liquid due to a transient exciting force. (auth)

3229 PLASMA DYNAMICS. Pai, S. I. (Univ. of Maryland, College Park). pp 333-78 of Modern Developments in Gas Dynamics. Loh, W. H. T. (ed.). New York, Plenum Press, 1969.

These problems of plasma dynamics are considered in which the plasma may be considered as a continuum, and the electromagnetic forces are of the same order of magnitude as gasdynamic forces and their interaction is important, particularly for cases in magnetofluid dynamics. The fundamental equations of the dynamics of an ionized gas are discussed, in which both the gasdynamic equations including the interaction of electromagnetic variables, and the electromagnetic field equations are given. The electromagnetic equations and the boundary conditions of electromagnetic fields are discussed further. The equations of magnetofluid dynamics and electrogasdynamics are presented. Various flow problems of magnetofluid dynamics and electrogasdynamics are discussed, including one-dimensional flows, channel flows, waves and shocks, boundary layer flow, and turbulent flows. Two improvements in the ordinary theory of magnetofluid dynamics, the tensor electrical conductivity and multifluid theory, are discussed. (M.H.R.)

3230 THEORETICAL AND EXPERIMENTAL STUDY OF THE RISE IN MAGNETOHYDRODYNAMIC FLOW. Chambarel, Andre (Univ., Vaucluse, France). Compt. Rend., Ser. A, 268: 1653-6 (June 30, 1969). (In French).

A theoretical and experimental study is presented for the rise of liquid electroconductor in a horizontal rectangular channel in the presence of a magnetic induction field, first vertical and then horizontal. (tr-auth)

3231 FLOWS BEHIND SPECIAL HYDROMAGNETIC SHOCKS. Ram, Rishi; Upadhyaya, K. S.; Mishra, R. S. (Banaras Hindu Univ., India. Univ. of Allahabad, India). Tensor, 20: 243-50 (Sept. 1969).

It is concluded that the vorticity and current density generated by an oblique hydromagnetic shock in three-dimensional unsteady flows depend upon dynamical as well as thermodynamical behavior of the fluid, whereas in some special cases of hydromagnetic shocks, vorticity and current density are derivable from purely dynamical relations without recourse to any thermodynamic law. (M.H.R.)

3232 UNSTEADY FLOW OF REINER–RIVLIN FLUIDS BETWEEN TWO POROUS PLANES IN A MAGNETIC FIELD. Madan, V. P.; Agrawal, J. C. (Univ. of Alberta, Edmonton. Purdue Univ., Lafayette, Ind.). Tensor, 20: 320-4(Sept. 1969).

The solution of unsteady hydromagnetic laminar flow of non-Newtonian visco-inelastic flows between two porous plates is given when there exists any time-dependent pressure gradient in the direction of the main flow. It is found that the solution of this problem involving a Green's function reduces to the determination of certain functions, which lead to a system of Volterra integral equations of the second kind with a regular kernel. The solution of the corresponding steady flow can be obtained from the unsteady one by taking the limits as $t \to \infty$. (M.H.R.)

3233 COMPLEX LAMELLAR HYDROMAGNETIC STEADY GAS FLOWS. Purushotham, G.; Rao, P. Sambasiva (Nagarjunasagar Engineering Coll., Hyderabad, India. Arts and Science Coll., Warangal, India). Tensor, 20: 343-6(Sept. 1969).

An electrically conducting ideal compressible fluid devoid of viscosity and thermal conductivity is studied. It is assumed further that the mean electric charge is zero (so that the medium is essentially neutral), that the displacement current may be neglected, and that electrical conductivity of the fluid is infinite. (M.H.R.)

3234 FLUID DYNAMICS TRANSACTIONS. VOLUME 3. Symposia on Advanced Problems and Methods in Fluid Dynamics Held at Jurata, Poland, September 1–7, 1965. Fiszdon, W.; Kucharczyk, P.; Prosnak, W. J. (eds.). Warszawa, Panstwowe Wydawnictwo Naukowe, 1967. 794p. (In several languages). (CONF-650933).

Fifty-four papers are included. Separate abstracts were prepared for three, two on MHD flow and one on plasma. (M.H.R.)

For abstracts of individual papers see: 3235, 3236, and 3381.

3235 INFLUENCE OF A MAGNETIC FIELD ON VORTICITY DISTRIBUTION IN PERFECTLY CONDUCTING, INCOMPRESSIBLE VISCOUS FLUID FLOW IN A CHANNEL. Fiszdon, W.; Szuster, J. T. (Dept. of Fluid Mechanics, Warsaw). pp 305-11 of Fluid Dynamics Transactions. Vol. 3. Fiszdon, W.; Kucharczyk, P.; Prosnak, W. J. (eds.). Warszawa, Panstwowe Wydawnictwo Naukowe, 1967.

From Symposium on Advanced Problems and Methods in Fluid Dynamics, Jurata, Poland. See CONF-650933.

The influence of a magnetic field parallel and perpendicular to the undisturbed fluid flow, on the variation of a harmonically oscillating vorticity distribution in the case of two-dimensional fluid flow in a channel is investigated. It is assumed that: the fluid is incompressible, viscous, and perfectly conducting, and that a specified vorticity distribution is obtained by means of a suitable vorticity generator in a given cross section of the channel. This can be achieved behind a blunt body or an oscillating sharp-edged plate. (M.H.R.)

3236 NONLINEAR APPROXIMATION FOR WEAK HYDROMAGNETIC SHOCK WAVE PROPAGATION. Zielke, W. (Dept. of Telecommunication, Warsaw). pp 423-34 of Fluid Dynamics Transactions. Vol. 3. Fiszdon, W.; Kucharczyk, P.; Prosnak, W. J. (eds.). Warszawa, Panstwowe Wydawnictwo Naukowe, 1967.

From Symposium on Advanced Problems and Methods in Fluid Dynamics, Jurata, Poland. See CONF-650933.

Propagation phenomena are studied in a perfect, infinitely conducting gas. The medium can be weakly inhomogeneous. The requirement concerning inhomogeneity is formulated. The Taylor expansion is used with respect to shock strength and only zero- and first-order terms are conserved. (M.H.R.)

Geophysics (Upper Atmosphere)

3237 (EGG-1183-435(Rev.)) AN EXCITATION COEFFICIENT MATRIX FOR ATMOSPHERIC TRANSMISSION IN THE 0.32 TO 0.70 μ WAVELENGTH RANGE. Technical Report Number B-3725A. Ouellette, R. J. (EG and G, Inc., Boston, Mass. Eastern Science and Technology Div.). Feb. 29, 1968. Contract AT(29-1)-1183. 41p. Dep. CFSTI.

For Los Alamos Scientific Lab., N. Mex.

A method is described for evaluating atmospheric transmittance in the 0.32- to 0.70-μ wavelength band for arbitrary locations of source and receiver in the 0- to 700-km altitude range. The formulation utilizes a detailed matrix of extinction coefficients as a function of wavelength and altitude, and includes (1) molecular (Rayleigh) scattering, (2) ozone absorption, (3) aerosol scattering, and (4) water vapor absorption. Input data appropriate to the Dominic high-altitude series are given special attention, and extinction coefficients for Starfish, Kingfish, and Checkmate are tabulated in the appendix. These coefficients and the atmospheric model are to be used to calculate transmission for Dominic events only when actual transmission measurements are lacking. The transmission matrix presented for the 0- to 50-km altitude range is nearly the same as that reported by Elterman in Handbook of Geophysics and Space Environment (1965). The only major difference in this altitude range is the use of the total ozone content measured at the times of the different Dominic events. In the 50-60-km altitude range, the total extinction coefficient is made up of ozone absorption (obtained by extrapolation from lower altitudes) and calculated Rayleigh scattering. In the 60- to 700-km altitude range, the total extinction coefficient is the calculated Rayleigh scattering coefficient. For all altitude ranges, water vapor absorption is separately calculated and is included in the overall transmittance for a particular source-receiver geometry. (auth)

3238 (N-69-36232) ELECTRON PRECIPITATION PULSATIONS. Its Ser. 10, Issue 37. Coroniti, F. V.; Kennel, C. F. (California Univ., Berkeley. Space Sciences Lab.). [1969]. 35p. (NASA-CR-105652). CFSTI.

When high-frequency wave turbulence is present, low-frequency micropulsations can strongly modulate the high-frequency wave amplitudes, leading to finite amplitude pulsations in the loss rate of energetic electrons from the magnetosphere, micropulsation amplitude is small. An extremely idealized model suggests that the precipitation modulation depends exponentially on the micropulsation amplitude, when the micropulsation period is less than the electron precipitation lifetime. (auth) (STAR)

3239 (N-69-36249) LOW-ENERGY PROTON ($0.5 \leq E \leq 50$ keV) OMNIDIRECTIONAL INTENSITY CONTOURS IN THE EARTH'S OUTER RADIATION ZONE AT THE MAGNETIC EQUATOR. Frank, L. A.; Owens, H. D. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). July 1969. Contracts NAS5-2054; Nonr-1509(06). 30p. (NASA-CR-105654). CFSTI.

Observations of low-energy proton intensities within seven selected energy bandpasses spanning the energy range $0.5 \leq E \leq 50$ keV are summarized in L value-versus-time diagrams for the period 10 June through 23 July 1966. These contours of omnidirectional, differential proton intensities were calculated via measurements of the directional, differential spectrums of the proton intensities with a sensitive electrostatic analyzer array borne on the earth satellite OGO 3 at mid- and low latitudes in the outer radiation zone and are normalized to a geomagnetic latitude 0° (magnetic equator). These L-versus-time diagrams provide a compact, useful summary of these unique observations of proton intensities over L values ranging from ≈ 3.0 to 12 and promote further insight into the morphological features of one of the most dynamically important components of magnetospheric plasma. (auth) (STAR)

3240 ON SOME ACCELERATION PROCESSES OF A CHARGED PARTICLE BY ELECTROMAGNETIC WAVES IN A STATIC UNIFORM MAGNETIC FIELD. Orefice, A. (Univ., Milan. CNR, Milan). Nuovo Cim., 63B: 638-48(Oct. 11, 1969).

The self-resonant motion of a charged particle in the field of a plane electromagnetic wave is studied in detail. In the case of "whistlers," the existence of trapped particles is shown, and some acceleration possibilities are suggested for a medium with a "slowly" varying refractive index. (auth)

3241 RADAR PULSE SCATTERING FROM IONIZED MEDIA. Harrison, Charles W. Jr.; Aronson, Eugene A. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 679-82(Sept. 1969).

Some preliminary work relating to the pulse radar return from ionized media, such as fireballs resulting from nuclear explosions and the wakes of high-speed reentry vehicles, is reported. In all cases the objective is to retrieve the envelope of the backscattered signal correctly related in time to the transmitted pulse. (auth)

3242 PROPAGATION OF THE ELECTROMAGNETIC PULSE WITH GAUSSIAN ENVELOPE IN INHOMOGENEOUS IONIZED MEDIA. Kozaki, S. (Gunma Univ., Kiryu, Japan); Mushiake, Y. IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 686-8(Sept. 1969).

For the purpose of radio communication, it is important to study the distortion of signals propagating through an inhomogeneous

medium. The problem of finding the distortion of a pulse after it has propagated through a plasma medium whose electron density varies linearly in one direction is discussed. A sinusoidal carrier with a Gaussian pulse envelope is assumed to be the source of the incident plane wave. (auth)

3243 INSTABILITY OF LOW-FREQUENCY WAVES IN A STREAM-MAGNETIZED PLASMA SYSTEM. Wang, T. N. C. (Stanford Research Inst., Menlo Park, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 690-2(Sept. 1969).

The interaction of low-frequency electromagnetic waves propagating at an arbitrary angle to the static magnetic field with a nearly synchronous charged stream along the field in a cold plasma is analyzed. The temporal growth of the waves is found to increase with the signal frequency, the stream density, and the propagation angle off the field line. Explicit forms of maximum growth rate are derived for vlf and elf waves, and a numerical example is given for a typical ionospheric plasma near the magnetic equator. (auth)

3244 SOME RELATIONSHIPS BETWEEN SOLAR X-RAY BURSTS AND SPA'S PRODUCED ON VLF PROPAGATION IN THE LOWER IONOSPHERE. Kaufmann, Pierre; De Barros, M. H. Paes (Mackenzie Univ., Sao Paulo, Brazil). Solar Phys., 9: 478-86(Oct. 1969).

This paper discusses SPA's measured at long vlf propagation paths in the lower ionosphere and their association with solar x-ray bursts observed by USNRL satellites in the 0 to 3, 0 to 8, and 0 to 20 Å bands. Excellent correlations were found between the SPA importances (in degrees per mm) and the logarithm of the x-ray burst peak intensities. A hardening of the x-ray-burst spectra is evident for increasing importance of SPA's; the threshold energy required for the occurrence of such anomalies was estimated, it is 4.3×10^{-5} ergs cm^{-2} sec^{-1} in the main ionizing band of 0 to 3 Å. It was also possible to derive the effective recombination coefficient at the normal D-region height of 70 km, this being $\alpha_r \approx 6 \times 10^{-6}$ cm^3 sec^{-1}; furthermore ion production rates were estimated during SPA's at heights below the reference level. (auth)

3245 VLF OBSERVATIONS OF AURORAL BEAMS AS SOURCES OF A CLASS OF EMISSIONS. Smith, R. L. (Univ. of Stanford, Calif.). Nature (London), 224: 351-2(Oct. 25, 1969).

Reference is made to an interesting vlf phenomenon, called auroral V emissions (AVES), concerning which little has been reported, and the dynamic spectra of a collection of AVES are shown (the phenomenon has also been called "short saucers" and "splashes"). The AVES shown have a fairly low-frequency minimum (near 0.5 kHz) and time scales of the order of 10s. The term AVE is based on the region of observation and the V-shaped or hyperbolic spectral appearance. The shape is often symmetrical, particularly for AVES with shorter time scales. The phenomenon has only been observed from satellites. Noise bands with distinct intensity minima at harmonics of the local proton frequency are often observed at the center of an AVE. Certain features of AVES suggest that the frequency versus time spectral form is the result of a spatial distribution of energy as a fucntion of frequency rather than of a temporal variation resulting from dispersive propagation, and a stationary spatial form is suggested. The natural suggestion for an AVE source is thus an auroral beam, and the main features of the spectral shape can be explained by assuming a limited region of generation along the auroral beam and propagation near the resonance cone to the satellite, each frequency having a unique ray path to the satellite. It would be of interest to detect the presence of auroral beams directly from vlf recordings, and it is considered that the Alouette satellite, with its large electric antenna, would be an ideal platform for such observations. The appearance of beam modes is discussed. Sometimes an AVE appears to show spatial variations with discontinuities at a sharply defined instant, and frequently an impulse is observed at the discontinuity. This impulse is probably from an auroral beam, but may result from a discontinuity of the electric field associated with a rapid electron density change. Some of the beam models appear to have a systematic broadening at the higher frequencies. (UK)

3246 CHARGED-PARTICLE MOTION IN THE GEOMAGNETIC FIELD. Antonova, A. E.; Shabanskii, V. P. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1802-8(Nov. 1968). (In Russian).

Charged particle motion in the geomagnetic field was analyzed in order to confirm previous data obtained at 1000 km, showing that the day maximum of electrons with $E_e > 230$ keV was found at the latitude $\Lambda = 72°$ and the night maximum at $\Lambda = 68°$; and the maximum of electrons with $E_e > 40$ keV was found at $\Lambda = 68°$ and at 76 to 78° latitude at night and day, respectively. (R.V.J.)

3247 ORIGIN AND PROPERTIES OF ADDITIONAL RADIATION RECORDED BY SATELLITES AT LOW ELEVATIONS. Igiat'ev, P. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1818-20 (Nov. 1968). (In Russian).

A relatively high radiation flux as compared to the primary radiation flux was measured by gas discharge counters. The additional flux consisted mainly of the particles from the Earth's atmosphere. Curves of the longitudinal dependence of the cosmic radiation according to STS-5 counter measurements at 1200 and 200 km and interpolated to the beginning of 1965 are analyzed. (R.V.J.)

Low-Temperature Physics

Refer also to abstracts 2343, 2348, 2916, and 3775.

3248 (COO-1569-35) ADIABATIC DEMAGNETIZATION CRYOSTAT FOR THERMAL EQUILIBRIUM NUCLEAR ORIENTATION. Smith, C. H.; Weyhmann, W. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Nov. 1968. Contract AT(11-1)-1569. 76p. Dep. CFSTI.

An adiabatic demagnetization cryostat for thermal-equilibrium nuclear orientation was designed and constructed. Using a slurry of chrome alum, glycerin, and water, a sample containing 8 μCi of ^{60}Co diffused into iron was cooled to 7 m°K. The temperature was calculated from the anisotropy of the γ radiation. The warmup rate of the sample after demagnetization was 0.1 m°K/hr at 10 m°K. (auth)

3249 (COO-1569-45) EXPERIMENTAL AND THEORETICAL STUDIES IN SOLID STATE AND LOW TEMPERATURE PHYSICS. Annual Progress Report, 1969. (Minnesota Univ., Minneapolis. Inst. of Tech.). Sept. 1969. Contract AT(11-1)-1569. 35p. Dep. CFSTI.

Research is reported on the following; superconductivity, theory of quantum crystals, theory of liquid He, quantum hydrodynamics of superfluid He, λ transition in $^3He-^4He$ mixtures, magnetism in metals, and magnetic properties of crystalline ^3He. (D.L.C.)

3250 (JPRS-49060) HIGH-TEMPERATURE SUPERCONDUCTIVITY PROBLEMS. Ginzburg, V. L. Translated from Priroda, No. 7, 11-17(1969). 16p. CFSTI.

An attempt is made to clarify the nature of the high-temperature superconductivity problem and the hopes for its future. First, the problem of superconductivity itself and the causes of its limited technological applicability are explored. Similarities between superfluidity and superconductivity are discussed. Various models proposed for materials that could have high-temperature superconductivity are mentioned. (M.H.R.)

3251 THERMODYNAMIC EQUILIBRIUM OF ROTATING SUPERFLUIDS. Putterman, Seth; Uhlenbeck, G. E. (Rockefeller Univ., New York). Phys. Fluids, 12: 2229-36(Nov. 1969).

The thermodynamic equilibrium of rotating liquid He II is investigated on the basis of the macroscopic Landau theory. After reviewing the classical theory of rotating fluids, it is shown that for He II the normal fluid component is in solid body rotation while the superfluid flow can be irrotational except for a set of vortex lines or vortex sheets which must be stationary in a reference frame rotation with the normal fluid. Therefore, an array of quantized vortex lines which rotate with the normal fluid can be considered to be in thermal equilibrium. The number and positions of the lines is determined by thermodynamic stability requirements. The dissipative effects must have the property that they vanish in equilibrium and that they drive the system to the state of equilibrium. It is further shown that the equations proposed by Khalatnikov fulfill these requirements. (auth)

3252 NORMAL-FLUID DENSITIES IN LIQUID HELIUM II UNDER PRESSURE. Romer, R. H.; Duffy, R. J. (Amherst Coll., Mass.). Phys. Rev., 186: 255-62(Oct. 5, 1969).

Measurements of the normal-fluid fraction ρ_n/ρ in superfluid helium were made by observing the period of torsional oscillation of a stack of disks, at pressures up to 25 atm, at temperatures from 1.45 K to the λ line. At all pressures, the temperature dependence of ρ_n/ρ is qualitatively similar to the previously observed behavior at the vapor pressure. At all temperatures, ρ_n/ρ is a monotonically increasing function of pressure. Comparison is made with values calculated by means of the two-fluid model from second-sound velocities and thermodynamic data; good agreement is observed, but it is necessary to take into account the fact that a commonly used approximation $C_p \cong C_v$ is seriously incorrect at high pressures. (auth)

3253 ON MARCELJA'S MODEL OF INEXACT LONG-RANGE ORDER IN SUPERCONDUCTORS OF SMALL DIMEN-

SIONS. Schmid, Albert (Stevens Inst. of Tech., Hoboken, N. J.). Z. Phys., 229: 81-4(1969).

The model mentioned in the title is derived from the Ginzburg–Landau free energy expression without quantization of the order parameter. (auth)

3254 EFFECT OF PRESSURE ON SUPERCONDUCTIVITY IN TRANSITION METAL ALLOYS. Gey, Wolfgang (Univ., Karlsruhe, Ger.). Z. Phys., 229: 85-96(1969).

Measurements of twelve alloys of the series Zr–Nb–Mo show a close correlation of dT_c/dp with the d-band structure of these alloys and suggest that the d-band is virtually rigid with respect to pressure. The results are not compatible with the empirical observation of McMillan that T_c is governed only by a phonon factor $M\omega^2$. (auth)

3255 SUPERCONDUCTING ORIGIN OF SPIKES IN THE DIFFERENTIAL CONDUCTANCE OF p–n AND POINT CONTACT TUNNEL JUNCTIONS. Shaw, Roger W. (Monsanto Co., St. Louis). J. Appl. Phys., 40: 4464-9(Oct. 1969).

Structure consisting of pairs of negative-going spikes in differential conductance vs bias voltage are reported for GaAs p–n junctions and for superconducting point contacts against a variety of conductors, including semiconductors. The spike pairs are symmetrically positioned about zero bias as in the previous observations of such structure by Shewchun and Williams and by Esaki and Stiles. Superconductivity is demonstrated to be essential to the phenomenon. A detailed model is discussed involving Josephson tunneling between microscopic particles within the semiconductor or point contact tunneling region. Temperature and low magnetic field data ($H < 3$ kOe) are in excellent agreement with the model while at higher fields the full interference pattern expected of a Josephson junction is not observed. (auth)

3256 RELATION BETWEEN CRITICAL EXPONENTS FOR THE LAMBDA PHASE TRANSITION IN LIQUID HELIUM. Mikeska, Hans-Juergen (Institut Max von Laue-Paul Langevin, Garching, Ger.). Z. Phys., 229: 57-61(1969).

A relation between critical exponents is derived that permits the experimental determination of a so-far-unknown combination of critical exponents for the λ-phase transition in liquid helium. (auth)

3257 CRITICAL CARRIER CONCENTRATION FOR SUPERCONDUCTIVITY IN A $CuRh_2Se_4$-BASED SYSTEM. Van Maaren, M. H.; Harland, H. B. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 30A: 204-5(Oct. 6, 1969).

In the system $CuRh_{2-x}Sn_xSe_4$ ($0 \leq x \leq 1$) electronic properties vary from metallic to semiconducting. The disappearance of superconductivity at $x \approx 0.5$ coincides with substantial changes in the dependence of the Hall coefficient and the electronic density of states upon composition. (auth)

3258 NONLINEAR EXCESS CONDUCTIVITY ABOVE THE SUPERCONDUCTING TRANSITION POINT. Tsuzuki, T. (Kyushu Univ., Fukuoka). Phys. Lett., 30A: 285-6(Nov. 3, 1969).

The nonlinear excess conductivity to a static field is calculated microscopically in the framework of the Ginzburg–Landau–Gorkov approximation. (auth)

3259 A NUMERICAL CALCULATION OF THE EXCITATION OF HELIUM II BASED ON THE HARD-SPHERE MODEL. Wong, K. W. (Univ. of Southern California, Los Angeles); Huang, Y. H. Phys. Lett., 30A: 292-4(Nov. 3, 1969).

Some numerical computations of a hard-sphere Boson system at liquid helium density are reported. These computations are based on an exact iteration process from nonlocal field operators and with the core diameter taken as 2.1 Å. The Hamiltonian includes only the repulsive hard core taken into consideration via the algebra for these field operators developed by other investigators. The numerical answer obtained at liquid helium density shows apparently no zero-momentum condensate. However, the excitation spectrum is very close to the experimental one. It is interesting to point out also that such a conclusion implies that the three-body term treated by Wu in the dilute case actually contributes zero here. (auth)

3260 DESTRUCTION OF SUPERFLOW IN UNSATURATED ^{4}He FILMS AND THE PREDICTION OF A NEW CRYSTALLINE PHASE OF ^{4}He WITH BOSE–EINSTEIN CONDENSATION. Sarfatt, J. (San Diego State Coll., Calif.). Phys. Lett., 30A: 300-1 (Nov. 3, 1969).

There exist model wave functions of He II which correspond to crystalline phases with Bose–Einstein condensation. The observed disappearance of third sound in unsaturated films with no latent heat, is interpreted as a new solid phase with a finite superfluid density. (auth)

3261 DIAMAGNETIC SUSCEPTIBILITY OF A SUPERCONDUCTOR ABOVE THE TRANSITION TEMPERATURE. Patton, Bruce R.; Ambegaokar, Vinay; Wilkins, John W. (Cornell Univ., Ithaca, N. Y.). Solid State Commun., 7: 1287-90(Sept. 15, 1969).

A model calculation is presented for the magnetization of a superconductor above its transition temperature, $T(H_{c2})$. The contribution of high energy fluctuations is treated in a fashion which is consistent with the microscopic theory and which differs from the treatment using the simple Ginzburg–Landau functional. The result is a generalization of the susceptibility to the case of finite applied field and allows the determination of a characteristic cutoff energy from experiment. (auth) (UK)

3262 INTRABAND AND INTERBAND SCATTERING IN THE RESISTIVITY OF HIGH-T_c β–W SUPERCONDUCTORS. Cohen, R. W.; Cody, G. D. (RCA Labs., Princeton, N. J.). Solid State Commun., 7: 1379-80(Sept. 15, 1969).

An inconsistency in a recent calculation of the electrical resistivity of β–W compounds that leads to unphysical behavior is pointed out. (auth) (UK)

3263 SUPERCONDUCTIVITY OF LANTHANUM AND CERIUM AT HIGH PRESSURES. Ratto, C. F. (Faculte des Sciences, Orsay); Coqblin, B.; d'Agliano Galleani, E. Solid State Commun., 7: 1387-90(Sept. 15, 1969).

A theoretical model involving the presence of an inner 4f shell is developed in order to explain the pressure dependence of the superconducting transition temperature of lanthanum and the presence of a superconducting high-pressure phase of cerium. (auth) (UK)

3264 FLUX QUANTIZATION WITHOUT OFF-DIAGONAL LONG-RANGE ORDER IN A THIN HOLLOW CYLINDER. Gunther, L.; Imry, Y. (Tufts Univ., Medford, Mass.). Solid State Commun., 7: 1391-4(Sept. 15, 1969).

It is pointed out that a hollow, cylindrically shaped superconductor can be thin enough so as to rule out Off-Diagonal Long Range Order but thick enough to display flux quantization. (auth) (UK)

3265 LONGITUDINAL ULTRASONIC ATTENUATION IN CLEAN TYPE-II SUPERCONDUCTORS. Cerdeira, Hilda A.; Cottingham, W. N.; Houghton, A. (Brown Univ., Providence). Solid State Commun., 7: 1409-12(Oct. 1, 1969).

The attenuation of longitudinal sound in clean type-II superconductors, near H_{c2}, was calculated using a nonperturbative method. It is shown that at low frequencies the attenuation rate depends strongly on the direction of propagation of the wave, and on impurity concentration. (auth) (UK)

3266 ENHANCEMENT IN SUPERCONDUCTING FLUCTUATIONS OF WEAKLY COUPLED LINEAR CHAINS. Barisic, S. (Faculte des Sciences, Orsay); Marcelja, S. Solid State Commun., 7: 1395-8(Sept. 15, 1969).

Within a framework of usual approximations it is shown that the fluctuation effects, although enhanced, remain small for a reasonably weak coupling between linear chains arranged in the three dimensional array. The measurable effects are predicted in thin films. (auth) (UK)

3267 FLOW OF SUPERFLUID HELIUM IN TERMS OF ACTION-ANGLE VARIABLES IN QUANTUM STATISTICS. Biswas, A. C. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 30A: 296-7(Nov. 3, 1969).

The mean Hamilton's equations relating the rate of change of the mean values of the number and the phase operators rigorously follow from the action-angle variables introduced through the coherent state representation. (auth)

3268 EXPERIMENTS ON THE CRITICAL BEHAVIOR OF TYPE-II SUPERCONDUCTORS IN HIGH MAGNETIC FIELDS. Saur, E. (Univ., Giessen, Ger.). pp 454-66 of Physics of Solids in Intense Magnetic Fields. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969.

From 1st Chania Conference, Chania, Greece. See CONF-670735.

Critical field curves and quenching curves (critical current vs field at 4.2°K) were measured in fields up to 230 kOe for Nb_3Al, Nb_3Sn, V_3Si, V_3Ga, NbN, and NbN containing ZrN. The experimental values of the critical field are tabulated together with theoretical values. (D.L.C.)

3269 HALL EFFECT AND TRANSVERSE VOLTAGES IN TYPE-II SUPERCONDUCTORS IN THE MIXED STATE. Williamson, S. J. (Faculte des Sciences, Orsay, France); Baixeras, J. pp 444-53 of Physics of Solids in Intense Magnetic Fields. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969.

From 1st Chania Conference, Chania, Greece. See CONF-670735.

Dip effects in the Hall voltage, Hall angle, and longitudinal voltage were measured in cold-rolled Nb–1% Zr ribbons at 4.2°K and various angles ϕ between the current and the rolling direction. A pronounced dip is observed at $H/H_{c2} \sim 0.4$ for $\phi = 90°$. The results are interpreted in terms of vortex–defect and vortex–vortex interactions. (D.L.C.)

3270 ULTRASONIC PROPAGATION IN HIGH-FIELD SUPERCONDUCTORS. Shapira, Y. (Massachusetts Inst. of Tech., Cambridge). pp 378-86 of Physics of Solids in Intense Magnetic Fields. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969.

From 1st Chania Conference, Chania, Greece. See CONF-670735.

The properties of high-field type-II superconductors (HFS) are compared with these of type-I superconductors, and it is shown that magnetic field effects on ultrasonic attenuation are negligible for type-I but appreciable for HFS. After attenuation in the normal state is examined, the case of attenuation in the mixed state is considered and equations derived. Theory and experiment are compared for V–42 at.% Ti and Nb–25% Zr alloys. (D.L.C.)

3271 VORTEX MOTION IN TYPE-II SUPERCONDUCTORS. McLean, W. L. (Rutgers-The State Univ., New Brunswick, N. J.). pp 290-304 of Electronic Structures in Solids. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969.

From 2nd Chania Conference, Chania, Greece. See CONF-680663.

The analogy between the motion of vortex lines in the classical perfect fluid and some nonequilibrium phenomena in type-II superconductors is discussed. Differences which limit the usefulness of the analogy are then considered. 34 references. (D.L.C.)

3272 BEHAVIOR OF TYPE-II SUPERCONDUCTORS IN VERY HIGH FIELDS. Hechler, K.; Saur, E. (Univ., Giessen, Ger.). pp 283-9 of Electronic Structures in Solids. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969.

From 2nd Chania Conference, Chania, Greece. See CONF-680663.

Experimental critical field and quenching curves are given for Nb_3Al, Nb_3Sn, V_3Si, V_3Ga, and NbN. The deviation from parabolic shape of the critical field curves was determined by plotting versus square of reduced temperature. Maki parameters α and selected spin-orbit effect λ_{so} were used to draw theoretical reduced critical field curves for the β-W compounds. Finally, the theory of Helfand and Werthammer for the reduced initial slope of the critical field curve as a function of the reduced mean number of collisions is shown to agree well with the experimental data. (D.L.C.)

3273 DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF METAL LAYERS ON THEIR THICKNESS. Kessel, W.; Ruehl, W. PTB Mitt., 79: 258-67(Aug. 1969). (In German).

The superconducting transition temperature of metal films depends on their thickness. The available experimental data concerning this correlation are compiled. These results on eleven different elements lead to two common mechanisms. With sufficiently thin films ($d < 200$ Å) the transition temperature always diminishes when the film thickness is lowered. Increasing transition temperature with decreasing film thickness is observed with films annealed to some extent, only. For many metals the shift in T_c follows the equation $\Delta T_c = a/d - b/d^2$ (d: film thickness, a and $b > 0$). A comprehensive review of the corresponding theories is given. None of them explain both mechanisms satisfactorily. 101 references. (auth)

3274 DYNAMICS OF BUBBLES IN SOUND FIELDS AT LOW TEMPERATURES. Mosse, Acher. Houston, Tex., Univ. of Houston, 1969. 148p.

Thesis.

A review is given of previous knowledge of bubble dynamics in normal and quantum liquids. An experimental investigation of the dynamics of bubbles in water, liquid nitrogen, liquid helium I and liquid helium II has been conducted by optical and acoustical means. The optical studies consisted of the making of high-speed movie pictures (3,000 frames/s) of visible cavitation in liquid helium I (Regime C) and in liquid helium II (Regime A). Cavitation was induced by means of a plane-wave system in water and a cylindrical wave system in liquid nitrogen and liquid helium. The noise produced by cavitation has been analyzed and typical examples of the spectrum are shown, together with a summary of the line spectra in all three liquids. A more detailed study was carried out for the half-frequency response present in the cavitation noise spectrum. This consisted of discrete measurements of its variation with the driving voltage, temperature, and static pressure. Chart recordings of the ambient sound pressure level were taken in liquid helium and liquid nitrogen to determine possible correlations between the audible cavitation threshold, the first harmonic response, the half-frequency response, and the background noise. The results of the present investigation are discussed in the light of existing theories and special attention is devoted to the effects of the unusual thermal transport mechanism in liquid helium II. (Diss. Abstr. Int., B)

3275 SUPERCONDUCTING SEMICONDUCTORS. Frederikse, H. P. R. (National Bureau of Standards, Washington, D. C.). pp 270-82 of Electronic Structures in Solids. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969.

From 2nd Chania Conference, Chania, Greece. See CONF-680663.

The major points of Cohen's theory with many-valley band structure are discussed. Experiments establishing superconductivity in $SrTiO_3$ are described; it is shown to be a type-II superconductor. Other superconducting semiconductors are also considered, and the dependence of the transition temperature on the carrier concentration is discussed. 36 references. (D.L.C.)

3276 RESISTIVE CRITICAL FIELD OF SEVERELY DRAWN NIOBIUM. Pearson, J. R.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). Appl. Phys. Lett., 15: 219-20(Oct. 1, 1969).

The resistive critical field of severely drawn Nb increases far beyond the predictions of the GLAG theory for a homogeneous type-II superconductor and becomes anisotropic. Although no model fits the situation exactly, nucleation of superconductivity at dislocation cell walls is a possible explanation. (auth)

3277 CORRELATION OF SUPERCONDUCTING PROPERTIES WITH THE BETA TO OMEGA PHASE TRANSFORMATION IN Ti–Cr ALLOYS. Luhman, T. S.; Taggart, R.; Polonis, D. H. (Univ. of Washington, Seattle). Scr. Met., 3: 777-82(Nov. 1969).

It is shown that inductance measurements of the superconducting transition temperature range are sensitive to inhomogeneities of alloy structure and composition. The results indicate that this is a valuable technique for studying phase transformations in alloys. (M.H.R.)

3278 TRAPPING OF NEGATIVE IONS IN TURBULENT SUPERFLUID HELIUM. Sitton, Donald M.; Moss, Frank (Univ. of Virginia, Charlottesville). Phys. Rev. Lett. 23: 1090-3(Nov. 10, 1969).

Capture and escape of negative ions by vorticity resulting from a supercritical heat current in liquid He II are demonstrated in the temperature range between 1.6 and 1.8°K. The vorticity is identical to that produced by rotation except for configuration of the individual lines. The escape probability was measured between 1.7 and 1.8°K and is in agreement with the theory of Donnelly. (auth)

3279 LOW-TEMPERATURE SATURATION OF THE SUPERCONDUCTING PROPERTIES INDUCED IN SILVER BY THE PROXIMITY EFFECT. Deutscher, G.; Lindenfeld, P.; Wolf, S. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev. Lett. 23: 1102-4(Nov. 10, 1969).

Critical-field measurements of silver layers sandwiched between two superconducting layers indicate that supercooling appears below a temperature T^* and that the supercooling field stays constant at low temperatures. A simple theoretical model is proposed that correctly predicts the temperature of saturation as well as the observed amount of supercooling, and leads to an estimate of 0.1 for NV for silver. This model further suggests that a $1/x$ spatial dependence of the order parameter in the silver should be observed in the ^3He temperature range and below. (auth)

3280 EVIDENCE FOR FLUCTUATION SUPERCONDUCTIVITY IN BULK TYPE-II SUPERCONDUCTORS. Hake, R. R. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev. Lett. 23: 1105-8(Nov. 10, 1969).

Electrical resistivity measurements on bulk specimens of very-short-coherence-distance [$(l\xi_0)^{1/2} \approx 50$ Å] type-II superconducting alloys suggest the presence of fluctuation superconductivity at temperatures up to at least $2T_c$, where T_c approximates the bulk superconducting transition temperature. Apparent magnetic field quenching of fluctuation superconductivity is observed up to 50 kG both above and below T_c. (auth)

3281 VORTEX MOTION IN TYPE-I SUPERCONDUCTORS. Maki, Kazumi (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 42: 448-60(Sept. 1969).

Making use of the time-dependent Ginzburg–Landau equations, the resistive behavior of the intermediate state in a type-I super-

conductor is studied microscopically. It is shown that an electric field induces a uniform motion of the order parameter (or the vortex lines) in the perpendicular direction to the static magnetic field and to the electric field. The motion of the vortex lines results in the resistivity as well as a large Ettingshausen effect of the intermediate state. In particular in the low field region (i.e., $B \ll H_c(T)$, where B is the induction and $H_c(T)$ is the critical field) the explicit expressions of the flow resistivity and the entropy carried by unit flux of vortices are obtained. (auth)

3282 THEORY OF A NONIDEAL BOSE GAS AND THE SIZE EFFECTS IN SUPERFLUID FILMS. Sonin, E. B. (Inst. of Semiconductors, Moscow). Zk. Eksp. Teor. Fiz., 57: 1411-20(Oct, 1969). (In Russian).

The dependence of the Bose condensation temperature of a nonideal Bose gas on the linear dimensions of the region occupied by the gas (size effect) is studied theoretically. Two variants of the theory of a nonideal Bose gas are considered. In one it is assumed that two quasi averages $\langle a_0 \rangle$ and $\langle a_0^+ \rangle$ exist, where a_0 and a_0^+ are the annihilation and creation operators at the ground level. In the sec-theory, a pair Hamiltonian is employed, and the single-particle excitation spectrum has a gap at small momenta $p \to 0$. The first theory leads to anomalous and the second to normal size effects. In the normal size effect the temperature of the Bose condensation depends on the magnitude of the smallest linear dimension, providing it is sufficiently small. In the anomalous size effect the dependence of the Bose condensation temperature on the ratio between the linear dimensions occurs for arbitrarily large values of the minimal linear dimension. (auth)

3283 FLUX FLOW IN THIN TYPE-I SUPERCONDUCTING FILMS. Tholfsen, Paul; Meissner, Hans (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 185: 653-63(Sept. 10, 1969).

Using dc and pulsed currents of 80-nsec duration, the flux-flow resistance has been observed at temperatures $T \geq 0.9\ T_c$ in flat films of tin of thickness 440 to 1580 Å in a perpendicular magnetic field $H_\perp$. At low values of $H_\perp$ the reduced flow resistivity ρ_f/ρ_n is given by $\rho_f/\rho_n = 0.76\ [H_\perp/H_{c\perp}(T)]^{\frac{1}{2}}$, which is in agreement with published data on bulk type-II superconductors. Flux flow is absent at temperatures $T \leq 0.9\ T_c$, and highly nonlinear for a film of 3420 Å thickness. The flux flow starts at a current density J_p where the flux tubes break free from their pinning centers. The dependence of J_p on magnetic field and temperature has been investigated both experimentally and theoretically. As the sample current is increased, an instability is observed at a current density J_I, at which the resistance increases sharply. The dependence of J_I on magnetic field, temperature, and film thickness has been determined. Close to T_c, the instability current J_I is almost independent of thickness and is given by $J_I = 3.0 \times 10^6[1 - (T/T_c)^2][0.9 - H_\perp/H_{c\perp}(T)]$ A/cm². An investigation of the time dependence of the sample voltage indicates the existence of a time constant t′ which, near T_c, decreases exponentially with current density. J_I is then defined as the current density at which t′ becomes shorter than the time of observation. (auth)

3284 NERNST EFFECT AND FLUX FLOW IN SUPERCONDUCTORS. III. FILMS OF TIN AND INDIUM. Rowe, V. A.; Huebener, R. P. (Argonne National Lab., Ill.). Phys. Rev., 185: 666-71(Sept. 10, 1969).

Flux motion induced by a temperature gradient and by an electrical current has been studied through the Nernst effect and the flux-flow resistivity in superconducting films of tin and indium. The film thickness ranged between 1 and 11 μm for tin and between 0.5 and 5 μm for indium. The data were taken at 2.0 K as a function of magnetic field and film thickness. In addition to the transport entropy of a fluxoid and the flux-flow resistivity, the critical thermal force and the critical Lorentz force, at which thermally induced and current-induced flux motion sets in, were determined. The transport entropy per unit length per unit flux, S_φ/φ, plotted versus film thickness was found to reach a maximum in Sn at about 7 μm and in In at about 3.5 μm. Around this maximum, S_φ/φ was larger by a factor of 1.4 in Sn and 1.6 in In than the value calculated from the difference in entropy density of normal and superconducting material. With increasing film thickness, the critical Lorentz force decreased, while the critical thermal force increased. The discrepancy between the critical Lorentz force and the critical thermal force and its dependence on film thickness suggests that in the films the critical current flows along special channels at the surface for which the interaction with fluxoids is strongly reduced. The results on Sn and In are consistent with the earlier results on Pb. (auth)

3285 CAPACITANCE EFFECTS IN SUPERCONDUCTING TUNNELING JUNCTIONS. Paterno, G.; Sacchetti, N.; Sacerdoti, G. (CNEN, Frascati, Italy). Phys. Rev., 185: 648-53(Sept. 10, 1969).

Measurements of the superconducting-tunneling-junction capacitance C_s are described, which show that C_s increases when one of the junction metals undergoes a superconducting transition. C_s increases as long as the temperature decreases, although at lower temperatures saturation of this effect seems to exist. Moreover, at fixed T, a sufficiently strong magnetic field restores the C_s value, which is measured when both metals are in the normal state. This phenomenon seems to depend strongly on the insulating-layer thickness. A qualitative discussion of the experimental results in terms of the penetration of the electric field into the metal electrodes is given. (auth)

3286 CRITICAL-FIELD RATIO H_{c3}/H_{c2} FOR PURE SUPERCONDUCTORS OUTSIDE THE GINZBURG–LANDAU REGION. II. $T \simeq T_c$. Hu, Chia-ren (Univ. of Maryland, College Park. Univ. of Illinois, Urbana); Korenman, Victor. Phys. Rev., 185: 672-82 (Sept. 10, 1969).

In Paper I the appropriate generalization of Gor'kov's linearized gap equation was found for a pure, semi-infinite weak-coupling superconductor in a magnetic field, separated from vacuum or an insulator by a specularly reflecting surface. In that paper the gap equation was used to study the surface-nucleation critical field H_{c3} at $T \simeq 0$°K. Here the region $T \simeq T_c$ is studied and the first three nontrivial terms in an expansion of the ratio $H_{c3}(T)/H_{c2}(T)$ are found to be $1.695[1 + 0.614(1-t) - 0.577(1-t)^{\frac{1}{2}}]$, where $t \equiv T/T_c$. The term linear in $1 - t$ has been found previously, but the last term is new. For T close enough to T_c it is shown that the system is accurately described by the linearized Ginzburg–Landau equation with the usual boundary condition and thus the results of Saint-James and de Gennes are regained. At lower temperatures the pair wave function has a slowly varying component which satisfies a finite-order differential equation and a surface component which does not. An analysis of the surface component gives an effective boundary condition on the slowly varying part; from this condition the field H_{c3} is derived. In combination with the results of Paper I an interpolation formula is proposed for the entire temperature range below T_c. A comparison with the available experimental data is encouraging. (auth)

3287 ABSENCE OF ANOMALOUS AVERAGES IN SYSTEMS OF FINITE NONZERO THICKNESS OR CROSS SECTION. Chester, G. V.; Fisher, Michael E.; Mermin, N. D. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 185: 760-2(Sept. 10, 1969).

It is shown that doubts concerning the validity of previous proofs that anomalous averages cannot occur in three-dimensional systems of finite cross section or thickness are unfounded. The absence of anomalous averages in Bose systems of finite cross section is explicitly demonstrated to illustrate the point. (auth)

3288 ABSORPTION OF SOUND IN A ^{3}He–^{4}He SOLUTION. Karchava, T. A.; Sakinkidze, D. G. (Inst. of Cybernetics, Tbilisi, USSR). Zk. Eksp. Teor. Fiz., 57: 1349-52(Oct, 1969). (In Russian).

Absorption of first, second, and fourth sounds in superfluid ^{3}He-^{4}He solutions is studied for arbitrary ^{3}He concentrations. It is shown that the absorption coefficients of first as well as second sounds depend on all second viscosity coefficients, whereas the fourth sound absorption coefficient depends only on a single second viscosity coefficient. The contribution of impurity diffusion to the sound absorptions is calculated. (auth)

3289 EFFECT OF PRESSURE ON THE SUPERCONDUCTING PARAMETERS AND THE SURFACE CURRENT IN NIOBIUM. Brandt, N. B.; Pann, E. (Moscow State Univ.). Zk. Eksp. Teor. Fiz., 57: 1090-1100(Oct. 1969). (In Russian).

The effect of hydrostatic pressure P up to 16 kbars on the superconductivity transition temperature T_c surface critical current I_c, and second (H_{c2}) and third (H_{c3}) critical fields is investigated in niobium. The measurements were performed by the harmonic analysis technique with single-crystal niobium samples possessing a resistance ratio $\rho(300°K)/\rho(4.2°K) = 20$ and variously treated surfaces. The maximum change in T_c at P = 16 kbars does not exceed 0.1°K. The quantities H_{c2} and H_{c3} approximately decrease under the action of the pressure at a rate of 11 and 20 Oe/kbar respectively. The surface critical current reversibly decreases with compression, the maximum effect (50% at P = 16 kbars) of the pressure being observed in a sample with the highest surface critical current at P = 0. It is shown that the observed strong decrease of the surface current cannot be explained by the Abrikosov or Fink–Barnes theories. (auth)

3290 FAST IONS IN LIQUID HELIUM. Doake, C. S. M.; Gribbon, P. W. F. (Univ. of St. Andrews, Scotland). Phys. Lett., 30A: 251-3(Oct. 20, 1969).

Evidence is presented for a new state of the negative ion in liquid helium, which has a higher mobility than the normal bubble ion. (auth)

3291 FLOW OF HELIUM II THROUGH FINE PORES. Jones, B. K. (Univ. of California, Los Angeles). Phys. Rev., 186: 164-7(Oct. 5, 1969).

Measurements are reported of the flow of He II through packed carbon powders with pore sizes 10 to 1000 Å. Considerable lowering of the superfluid transition temperature was observed and found to correspond with measurements made with fourth sound. An analysis is presented of the temperature dependence of the flow rate near the transition temperature. (auth)

3292 CRITICAL VELOCITIES OF IONS IN LIQUID HELIUM. Jones, B. K. (Univ. of California, Los Angeles). Phys. Rev., 186: 168-74(Oct. 5, 1969).

A model using quantized vortex rings is presented to describe the observed temperature dependence of the small quantized changes of ion mobility in He II at low electric fields. The trapping and release of ions by vortices at high fields is also discussed. (auth)

3293 DILUTE BOSE SYSTEM OF HARD SPHERES. Khanna, K. M. (Dibrugarh Univ., India). J. Phys. Soc. Jap., 27: 1093-45 (Nov. 1969).

A realistic calculation of the normal-superfluid phase transition temperature of a dilute Bose system of hard spheres is presented. From the finiteness of the transition temperature it is concluded that such an assembly will be a stable assembly. (auth)

Plasma and Thermonuclear Physics

Refer also to abstracts 2972, 3140, and 3915.

3294 PLASMA PHYSICS: TECHNOLOGY INDEX. VOLUME 3, NO. 9, 1969. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main, Zentralstelle fuer Atomkernergie-Dokumentation, 1969. 89p.

179 articles on various aspects of plasma physics are listed. (M.O.W.)

Confinement and Heating

Refer also to abstracts 3365, 3382, and 3480.

3295 (AEC-tr-7002(Rev.)) INVESTIGATION OF AN ELECTROMAGNETIC TRAP. Lavrent'ev, O. A. Translated by T. Dolan (Univ. of Illinois, Urbana), from pp 77-147 of Magnitnye Lovushki, Vypusk 3, Naukova Dumka, Kiev, 1968. 122p. Dep. CFSTI.

An extensive survey was made of work dealing with electrostatic plasma confinement. An analysis is given for each of the following four topics: (1) electrostatic plasma confinement, (2) magnetic protection of the grid, (3) electromagnetic traps, and (4) experimental investigation of an electromagnetic trap. (M.O.W.)

3296 (MATT-Trans-93) TRANSPORT COEFFICIENTS IN A PLASMA IN THE TM-3 TOKAMAK. Bobrovskii, G. A.; Kuznetsov, E. I.; Razumova, K. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translation of report IAE-1906. 19p. Dep. CFSTI.

The experimental data are compared with the data calculated by theoretical formulas proposed by A. A. Galeev and R. Z. Sagdeev. For a sufficiently high plasma concentration, the experimental values of the energy losses turn out to be on the order of the classical values. In the case of a collisionless plasma, significant divergences are observed. (auth)

3297 (N-69-33418) FLUCTUATION THEORY OF AMBIPOLAR DIFFUSION IN A MAGNETO-PLASMA. Tchen, C. M. (City Coll., New York). [1969]. 4p. (NASA-CR-103790). CFSTI.

Weakly ionized plasmas in a strong magnetic field and small fluctuations are considered. The results show that the theory is valid for plasmas in large-scale turbulent motion, and where such a turbulence ceases and is replaced by microdisturbances. The hydrodynamic equations, transport coefficients, and equations of motion are submitted in proof of the theorem. (STAR)

3298 (UR-4054-6) AN EXPERIMENTAL INVESTIGATION OF LASER PLASMA INJECTION IN A TOROIDAL MULTIPOLE. A. MICROWAVE HEATING RESULTS. Annual Progress Report, November 15, 1968-November 14, 1969. Lubin, Moshe J. (Rochester Univ., N. Y.). Contract AT(30-1)-4054. 32p. Dep. CFSTI.

ECRH-produced plasmas in the high-field quadrupole exhibit $\tau_i \sim B^2$ behavior within the $\phi dl/B$ stable region beyond a critical value of magnetic field. Data reduction is presently underway on a correlation of fluctuation level with anomalous radial loss. An estimate of the initial conditions for the plasma decay studies is in good agreement with measured densities and electron temperatures. The B^2 behavior of the confinement time indicates that in the back-biased condition (yielding a peak magnetic field of 18 kG), this quadrupole is a workable geometry for laser plasma studies. (auth)

3299 EXPERIMENTS AND OBSERVATIONS ON POLARIZED PLASMA INJECTION. Barney, Gerald O. (Univ. of Wisconsin, Madison). Phys. Fluids, 12: 2429-33(Nov. 1969).

The injection of a plasma stream into a transverse magnetic field by polarization and $E \times B$ drift is considered in terms of a simple model. An estimate of the peak flux density that the plasma can enter is discussed. An expression for the magnitude of the diamagnetism associated with the particle velocity distribution is indicated. Experiments on the motion of a plasma stream through regions of shorted (or tied) field lines show that a sheath forms on the shorting electrode and that the plasma can penetrate through the shorted lines because the discharge current is limited to the ion saturation current. An expression for the stopping distance is derived. (auth)

3300 TANGENTIAL INJECTION OF PLASMA INTO A TOROIDAL MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 327-32(Sept. 1969).

Translated from Zh. Tekh. Fiz., 39: 444-51(Mar. 1969).

The results of an investigation of plasma injection into a magnetic field with toroidal geometry in a direction tangential to magnetic field lines are described. The injected stream intersects the region where transverse components of the magnetic field and the polarization field reverse sign. Under these conditions the plasma passing the region of zero transverse magnetic field undergoes polarization interaction with flow trapped at the entrance to the magnetic field and having opposite polarization. Owing to the cancellation of the polarization, a complete stoppage of the plasma stream motion across the magnetic field lines occurs and the plasma moves along the field and does not experience drift in the radial direction. (auth)

3301 TURBULENT HEATING OF IONS IN A PLASMA WITH A STRONGLY NONUNIFORM MAGNETIC FIELD. Aref'ev, V. I. Zk. Eksp. Teor. Fiz., 57: 1376-86(Oct. 1969). (In Russian).

High-frequency ($\omega_{Hi} \ll \omega \ll \omega_{He}$) drift instabilities of a plasma with a strongly nonuniform magnetic field are considered. The ions are assumed to be hot ($T_i \gg T_e$) and unmagnetized in the oscillations under consideration. It is shown that under these conditions the oscillation spectrum is continuous. Spectral spreading of the oscillations is due to the thermal spread of the centrifugal and diamagnetic drift velocities. Anomalous ion heating and the anomalous resistance in installations of the "Zeta" type caused by small-scale turbulence are discussed. (auth)

3302 NEGATIVELY CHARGED OPEN-ENDED PLASMA TO STRIP AND CONFINE HEAVY IONS. Stix, Thomas H. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett. 23: 1093-7 (Nov. 10, 1969).

A negatively charged plasma with energetic magnetic-mirror-confined electrons may provide a suitable environment for long-term ion confinement and for intense multiple ionization of heavy ions. Classical rates for ion loss from the negative potential well are low compared with the comparable ion mirror-loss rates. It is proposed to maintain the plasma by steady electron injection together with cyclotron acceleration for electron trapping and heating. (auth)

Diagnostics

Refer also to abstracts 3335 and 3337.

3303 (AD-692511) A SPECTRAL DIAGNOSTIC METHOD FOR DETERMINING INTERNAL PROPERTIES OF ASYMMETRICAL PLASMAS. Final Report. Olsen, Harry N.; Kelly, F. L.; Price, L. L. (Plasma Sciences Labs., Inc., Van Nuys, Calif.). Apr. 1969. Contract F33615-67-C-1071. 123p. (ARL-69-61). CFSTI.

A numerical method was developed for inverting the integral equation that relates the emitted spectral intensity to the internal emission coefficient for optically thin plasmas. The method is applicable to both symmetric and asymmetric plasmas with no prerequisite orientation of the source with respect to the laboratory coordinate system. The validity of the series representation of the emission coefficient was checked by means of a hypothetical model consisting of a source whose emission coefficient is taken as a displaced symmetric Gaussian function. The method was further tested by applying it to a symmetric experimental argon arc displaced with respect to the coordinate system to simulate an asymmetric plasma. The fully developed method was used as a practical diagnostic tool to investigate the internal properties of a generally asymmetric experimental plasma produced

by interacting the free-burning argon arc with an external magnetic field. Initial steps have been taken to develop a practical method for diagnostics of optically thick plasmas without requiring any direct measurements of the transmission along the path of integration by means of reflection optics or an external source of radiation. (auth) (USGRDR)

3304 (AEC-tr-7101) ABSOLUTE MEASUREMENT OF PLASMA PARAMETERS. Popov, S. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Preprint No. 161. 30p. Dep. CFSTI.

The possibilities of obtaining absolute measurements of a number of basic plasma parameters by means of a drift mass spectrometer, in which a receiver with a voltage barrier is used as a current receiver are discussed. (auth)

3305 (LA-tr-69-27(Draft)) DETERMINATION OF THE LOCAL VALUES OF PLASMA PARAMETERS BY THE ENERGY ABSORPTION OF A REFRACTING MICROWAVE BEAM. Dushin, L. A.; Pimkin, V. A.; Skibenko, A. I.; Fomin, I. P. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report NP-17785. 14p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 18601. (M.O.W.)

3306 (N-69-36755) SPECTROSCOPIC STUDY OF A HELIUM ARC. Scherrer, Victor E. (National Aeronautics and Space Administration, Cambridge, Mass. Electronics Research Center). Sept. 1969. 13p. (NASA-TN-D-5396). CFSTI.

A plasma source with characteristics desired for astrophysical spectral measurements is described. A high-frequency (1-MHz) capacitor discharge through an arc tube containing needle electrodes heated helium to kinetic electron temperatures varying from 10 eV to over 100 eV. Diagnostic measurements included time-resolved spectroscopy and high-speed photography. (auth) (STAR)

3307 (N-69-36939) FEASIBILITY OF DETECTING RADIATION SCATTERED FROM A PLASMA. Clark, Melville Jr. (National Aeronautics and Space Administration, Cambridge, Mass. Electronics Research Center). Sept. 1969. 56p. (NASA-TN-D-5311). CFSTI.

It is shown that it is possible to detect radiation scattered from a plasma in Doppler-shifted lines. The method provides a way of measuring the fluctuation in plasma charge density. (auth) (STAR)

3308 (NP-tr-1857) LASER SCATTERING AS A PLASMA DIAGNOSTIC TECHNIQUE PHYSICAL FOUNDATIONS. Dushin, L. A.; Pavlichenko, O. S. Translated for Culham Lab., Abingdon, Eng., from pp 81-94 of Issledovanie Plazmy s Pomoshch'yu Lazerov, Atomizdat, 1968. 17p. (CTO-634). Dep. CFSTI (U. S. Sales Only).

The following topics are discussed: (1) scattering of electromagnetic waves in a plasma, (2) spectra of electron density fluctuations in an isothermal plasma, (3) spectra of the electron density fluctuations in a nonisothermal plasma, (4) scattering of electromagnetic waves in an unstable plasma, and (5) nonlinear processes during the interaction of electromagnetic waves in a plasma. (M.O.W.)

3309 SATURATION CURRENTS TO LANGMUIR PROBES IN A COLLISION-DOMINATED PLASMA WITH UNIFORM MAGNETIC FIELD. Cohen, Ira M. (Univ. of Pennsylvania, Philadelphia). Phys. Fluids, 12: 2356-61(Nov. 1969).

Electrostatic probe theory for a slightly ionized, collision-dominated plasma is extended, in the sense of problem formulation, to allow for the presence of a uniform magnetic field. Provided that the Debye length is very much smaller than a probe dimension, ion and electron currents to the probe saturate, respectively, at large negative and positive probe bias with respect to the plasma potential. It is shown that it is not necessary to go through a lengthy asymptotic analysis to compute the saturation currents. Ion and electron saturation currents to ellipsoids of revolution inclined at an arbitrary angle to the magnetic field are given in compact form in terms of common elliptic functions. (auth)

3310 EFFECT OF MAGNETIC FIELD ON PROBE MEASUREMENTS IN ATMOSPHERIC PRESSURE PLASMA. Kanzawa, Atsushi (Tokyo Univ.). Nippon Koku Gakkaishi, 17: 333-8 (Sept. 1969). (In Japanese).

The effect of magnetic fields (up to 15,000 G) on probe measurements in weakly ionized argon plasma flow (the charged-particle density ~ 10^9 cm^{-3}) at 1 atm, in an arc discharge was experimentally investigated. The probe was so placed that its surface was parallel or perpendicular to the magnetic field, whose direction coincides with that of the plasma flow. It was found that the ion currents are hardly changed and the electron currents are greatly reduced by the magnetic field, even in the case of the perpendicularly placed probe. Besides, it was noticed that the reduction ratios of the electron currents are in the same order of magnitude as the value of $D_\perp/D_\parallel$, the ratio of the electron diffusion coefficient to the magnetic field-free electron diffusion coefficient. (NSA of Japan)

3311 CHARACTERISTICS OF GUARD-RING PROBE IN MAGNETIC FIELD AND MEASUREMENTS OF SPACE POTENTIAL. Akazaki, Masanori; Watanabe, Yukio (Kyushu Univ., Fukuoka). Kyushu Daigaku Kogaku Shuho, 42: 150-4(Mar. 1969). (In Japanese).

Space potential in a plasma was measured with a plane probe provided with a guard ring to make the edge effect negligible. In a magnetic field, such a probe shows negative V-I characteristics at saturating electron currents. The discharge tube was 30 mm in dia with 240 mm distance between electrodes, and contained Hg gas at a vapor pressure corresponding to the ambient temperature. V-I characteristics of the probe showed that negative characteristics appeared in the magnetic field above 20 G, and the measurement was in qualitative agreement with the theoretical analysis. Variation of critical field with discharge current was found, and an explanation is given. It was concluded that the probe voltage for the maximum current represents the space potential, when errors arising from the edge effect are negligible. The space potential thus measured was compared with the "apparent" space potential measured by the usual method, and with the theoretical value calculated with the formula of floating potential. Agreement with theory was rather good. The "apparent" space potential shifted to the negative side of real potential when the magnetic field increased. (NSA of Japan)

3312 CHARACTERISTICS OF SOUNDING PROBE IN A MAGNETIC FIELD. Akazaki, Masanori; Watanabe, Yukio (Kyushu Univ., Fukuoka). Kyushu Daigaku Kogaku Shuho, 42: 155-61(Mar. 1969). (In Japanese).

The use of a sounding probe in the presence of a magnetic field was examined. A sounding probe of 0.2 mm ϕ was placed in front of a guard-ring probe of 4 mm ϕ in a discharge tube of 240 mm in electrode distance filled with Hg gas. The probe surface was set parallel to the axial magnetic field, which varied from 0 to 60 G. The bias voltage of the sounding probe (with reference to anode) was varied from 0 to 70 volts, and the corresponding I-V characteristics were measured and illustrated. For an intermediate-bias voltage, even in zero magnetic field, shift of the peak of current to the negative side of the probe potential was observed. In presence of the magnetic field, this shift occurred except for very large negative bias voltage, for which the peak of current coincided well with the peak of current in the guard-ring probe, and use of a sounding probe is permissible. Theoretical explanation is also given. (NSA of Japan)

3313 MEASUREMENT OF THE ELECTRICAL PROPERTIES OF A FLOWING PLASMA, INCLUDING A CRITICAL COMPARISON OF PROBE EXPERIMENT AND THEORY. Billington, E. W. (Royal Armament Research and Development Establishment, Fort Halstead, Eng.). J. Plasma Phys., 3: 161-78(May 1969).

The primary quantities characterizing the electrical carriers of a flowing plasma in a low-density wind tunnel were determined from measurements using electrostatic probes immersed in the plasma. With the exception of the ion temperature, the plasma parameters were obtained from the current–voltage characteristics of two types of single electrode probe. The probes consist of a cylinder, the major axis of which is aligned parallel to the flow of the plasma, and a disk, the exposed surface of which is normal to the direction of flow. Experiments with a double electrode probe consisting of a disk-shaped collector electrode, screened from direct exposure to the plasma by a fine-wire-mesh grid electrode, made it possible to obtain current–voltage characteristics with the ion and electron components separated from one another. From the current–voltage characteristic corresponding to collection of ions, using the screen grid probe, values of the ion temperature and drift velocity were obtained. The measurements were made at various points along the center line of flow for one particular value of the flow rate, using argon as the test gas. For a given position of the probes, one value of the ion temperature was evaluated, together with two independent values of each of the other primary quantities characterizing the electrical carriers of a flowing plasma. Each pair of values agree satisfactorily among themselves, good agreement being generally obtained between probe theory and experiment. (auth) (UK)

3314 ION DENSITY AND CURRENT DISTRIBUTIONS IN A PROPAGATING CURRENT SHEET DETERMINED BY MICROWAVE REFLECTION TECHNIQUE. Ellis, W. R.; Jahn, R. G. Princeton Univ., N. J.). J. Plasma Phys., 3: 189-213(May 1969).

Electron and ion density distributions and the problem of electron/ion current partitioning were studied in a large-radius Z pinch in argon. Radial scans of the electron density and temperature profiles in the propagating sheet were obtained with a multipurpose microwave interferometer which measures the complex reflection coefficient from the plasma. At 70 GHz, the probe resolves densities up to 10^{17} cm^{-3} over dimensions of ~4 mm. Profiles of the electric and magnetic field components are obtained using standard probe techniques, and these data are used to calculate ion and electron current components in the sheet. Within the approximations of MHD theory, calculations show that the overall axial current pattern is built up of four interior zones alternately dominated by electron or ion current. This structure is observed to be closely correlated with variations of the Hall parameter, about the value of unity through the sheet, which suggests that this parameter might be used as a guide to the relative importance of ion conduction in pinch-discharge current sheets. (auth) (UK)

3315 EFFECT OF REFRACTION ON THE INTERFEROMETRIC MEASUREMENTS OF ELECTRON DENSITY. Anichin, B. (Boris Kidrich Inst. of Nuclear Physics, Belgrade). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 354-6(Sept. 1969).
Translated from Zh. Tekh. Fiz., 39: 478-82(Mar. 1969).

Using the geometric-optics approximation, consideration is given to the error in microwave interferometry of a plasma when using certain channels, which arises due to refraction and due to the shift of the beam at the aperture of the receiving antenna. In the case of a parabolic electron density distribution, the maximum error is approximately equal to twice the ratio of the maximum density to the critical density. (auth)

3316 DETERMINATION OF NEGATIVE ION CONCENTRATIONS BY A PHOTODETACHMENT FLASH. Taillet, Joseph (Office National d'Etudes et Recherches Aerospatiales, Hauts-de-Seine, France). Compt. Rend., Ser. B, 269: 52-4(July 16, 1969). (In French).

A new method is presented for determining negative ion concentrations in a plasma, characterized by the use of an intense radiation acting during a very short time. (tr-auth)

3317 TEMPERATURE AND DENSITY MEASUREMENTS IN THE MIDPLANE OF A LONG THETA PINCH. Beach, A. D.; Bodin, H. A. B.; Bunting, C. A.; (and others) (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion, 9: 215-22(Oct. 1969).

Plasma parameters were measured in an 8-meter-long theta pinch. The plasma in the midplane is found to be free of end effects and energy loss for some tens of microseconds and is characterized by electron densities of 2 to 5×10^{16} electrons/cm^3 and temperatures of 100 to 300 eV. The measured radial distributions of temperature and density and their dependence on voltage and filling pressure were in agreement with MHD-code calculations using an anomalous resistivity previously shown to account for the diffusion in the early stages. (auth)

3318 USE OF A POLYCRYSTALLINE PROBE IN PLASMA DIAGNOSTICS. Haug, Robert; Lebas, Jacques (Faculte des Sciences, Nancy). Compt. Rend., Ser. B, 269: 181-3(July 28, 1969). (In French).

The distribution function from the process of withdrawing a polycrystalline metallic surface used as a plasma probe is the kernel of a linear integral equation developed by interposing the distribution function for plasma particle energies and a derivative of the collected current. (tr-auth)

3319 METHODS OF DETERMINING THE DENSITY AND TEMPERATURE DISTRIBUTION OF A PLASMA USING ELECTROMAGNETIC WAVES. Nemov, V. V.; Sizonenko, V. L.; Stepanov, K. N.; Teichmann, J. (Inst. of Physics and Tech., Kharkov). Nucl. Fusion, 9: 243-51(Oct. 1969).

Methods of determining the density and temperature distributions along the radius of a plasma cylinder are considered, namely: (1) Determination of the electron density and temperature distributions by measuring the electron cyclotron damping or the phase of an electromagnetic wave passing in a straight line through a plasma cylinder as a function of the "sighting" distance. If the electron velocity distribution is not Maxwellian, additional measurements of the absorption or the phase as a function of the magnetic field or of the angle between the direction of the ray and the magnetic field enable one to find the electron velocity distribution function along the magnetic field at each point in the plasma cylinder. (2) Determination of the plasma density distribution from the fraction of a microwave ray passing through a plasma in a direction perpendicular to the magnetic field, and determination of the effective collision frequency distribution from damping of the intensity of the refracted ray. (3) Determination of the temperature of a plasma in a strong magnetic field from the measured frequency dependence of the absorption of low-frequency electromagnetic waves under conditions of acoustic resonance. (auth)

3320 RATES OF ELECTRON-IMPACT TRANSITIONS BETWEEN EXCITED STATES OF HELIUM. Johnson, L. C.; Hinnov, E. (Princeton Univ., N. J.). Phys. Rev.: 187: 143-52(5 Nov 1969).

Measurements of electron densities and population densities of excited states of neutral helium are presented for afterglows in the C stellarator. Electron densities range from 10^{11} to 3×10^{13} cm^{-3}, and electron temperatures range from 0.04 to 1 eV. Semiempirical cross-section formulas for transitions among excited levels are deduced by comparing observed excited-state population densities with solutions of detailed transition-rate equations. The agreement between computed and measured values is good, when the assumed cross sections are comparable with impact-parameter approximation results; the agreement is poor — especially at low electron densities and temperatures — when classical cross sections are assumed. (auth)

Kinetics (General)

Refer also to abstract 3229.

3321 (JINR-P9-4653) IONIZATION OF ATOMIC BEAMS IN THE PENNING DISCHARGE WITH A HOT CATHODE. Plis, Yu. A.; Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 21p. (In Russian). (CONF-690803-32). Dep. CFSTI (U. S. Sales Only).
From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The characteristics of the Penning discharge with a hot cathode were investigated in the high-vacuum regime and in conditions of the atomic beam ionization. The parameters of the apparatus are given which were used for measurements of: geometrical dimensions, magnetic field strength, anode voltage, discharge current, gas pressure in the discharge region, and value of the output ion current. Constitution of the beam from the discharge passing along the magnetic field was investigated; the electron and ion components are separated. The efficiency of atomic beam ionization in the discharge is estimated. (auth)

3322 STUDY OF AN OSCILLATORY ELECTRON–ION DISCHARGE IN A LONGITUDINAL MAGNETIC FIELD. Rashkovan, V. M.; Demutskii, V. P.; Khizhnyak, N. A. (Inst. of Aviation, Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 333-7 (Sept. 1969).
Translated from Zh. Tekh. Fiz., 39: 452-7(Mar. 1969).

A flux of neutral particles was extracted from an oscillatory discharge, and a qualitative comparison of the theory with experimental results was made. The discharge apparatus is described. (M.O.W.)

3323 A NEW METHOD OF DETERMINING THE TRANSPORT COEFFICIENTS FOR HIGH-PRESSURE ARCS FROM EXPERIMENTAL DATA. Kapp, L. B.; Richards, P. H. (Central Electricity Generating Board, Southampton, Eng.). J. Plasma Phys., 3: 269-80(May 1969).

The problem is to determine the electrical and thermal conductivities of high-pressure arc plasmas from measurements of the current–voltage characteristics of the arc and a single radial temperature profile. A new numerical method is described, together with the corresponding computer program. The latter is applied to some recent measurements on wall-stabilized nitrogen arcs, covering the temperature range 4500 to 11,000°K, for which radiation can be neglected, and the results are compared with those of other workers. (auth) (UK)

3324 RADIAL ELECTRIC POTENTIAL BOUNDARY OF PLASMA IN A GLASS TUBE WITH METALLIC THIN FILM. Takahashi, Shigeo (Yamanashi Univ., Kofu, Japan). Yamanashi Daigaku Gakugeigakubu Kenkyu Hokoku, No. 19, 254-7(1968).

The frequency of the oscillations generated by an electron beam in a cesium plasma in a longitudinal magnetic field, was analyzed. Cold beam and cold plasma approximations were used. Dispersion relations of various waves of the beam, and of the plasma were plotted on the same diagram, and two points of intersection, A and B, at which the coupling took place, were determined. Numerical calculation was made for the case when the beam energy was 500 eV and magnetic field strength was 150 G. The result depended on the choice of parameter r, radius of electric potential, and agreed with the measurement when r coincided with the radius of the cylinder, 3 cm. This can be explained by a thin metallic film formed on the inner wall of the cylinder. The thin film thus formed acts as a conductor, at least for radiofrequency, and works as the potential boundary in the system. (NSA of Japan)

3325 STUDY OF THE IONIC POPULATION OF A NITROGEN PLASMA. Leclert, Gerard; Meyer, Rene-Luc (Laboratoire de Physique des Milieux Ionises, Nancy). Compt. Rend., Ser. B, 269: 109-11(July 21, 1969). (In French).

The use of an ionization formula permits a relation of N^+ and N^{++} ion densities at plasma temperatures to be established. This relation depends strongly on the form of the electron distribution function. The comparison of numerical calculations with experimental measurements shows that the high-energy part of the electron distribution function is in the vicinity of the Druyvesteyn function. (tr-auth)

3326 THEORETICAL AND EXPERIMENTAL STUDY OF A TURBULENT PLASMA JET. Sivirkin, V. F.; Rogachev, N. M. Inzh.-Fiz. Zh., 17: 437-46(Sept. 1969). (In Russian).

A method of calculation for a turbulent submerged plasma jet is suggested. The assumption of the theory concerning rectilinear jet boundaries was confirmed by the experiments. The comparison of calculated with experimental data allows recommendation of calculation techniques for jets at temperatures 5,000° and above. (auth)

3327 CESIUM PLASMA RESEARCH. D'Angelo, N. (Research Establishment, Risoe, Denmark. ESRIN, Frascati, Italy). Advan. Plasma Phys., 2: 1-46(1969).

A review of research is given for the following topics: (1) typical cesium plasma devices, (2) wall recombination, (3) experiments of plasma confinement, (4) transport properties, (5) end effects, (6) waves and instabilities, (7) alkali plasmas with $T_e/T_i > 1$, (8) alkali plasmas with negative ions, and (9) spectroscopy experiments. (M.O.W.)

3328 SHOCK WAVES IN PLASMA PHYSICS. Chu, C. K.; Gross, Robert A. (Columbia Univ., New York). Advan. Plasma Phys., 2: 139-202(1969).

The following topics are discussed: (1) shock waves in fully ionized plasmas, (2) ionizing shock waves, and (3) high-energy shock waves. (M.O.W.)

Kinetics (Experimental)

3329 (AD-689277) TRANSPORT PROPERTIES IN HIGH POWER ARCS. Interim Scientific Report, February 1, 1967-December 31, 1968. Maecker, Heinz (Technische Hochschule, Munich (West Germany). Elektrophysikalisches Institut). Feb. 21, 1969. Contract F61052-67-C-0081. 47p. (ARL-69-31). CFSTI.

Improved measurements of the E-I characteristics for H_2 and N_2 as well as of the radial temperature distributions up to 26,000°K for N_2 are accomplished. Together with the already measured temperature distributions in H_2 a set of experimental results suitable for the determination of material functions is available now. For H_2 a computer program is developed to evaluate the electrical conductivity G(T), the heat flux potential S(T) and the thermal conductivity K(T) by an iteration method. The final results for these material functions up to 26,000°K are given. In the case of N_2 the energy transport by radiation which is partially reabsorbed within the arc, becomes dominant above 10,000°K. Therefore, special methods are applied to determine G(T), K(T), and u(I,T), the differences between emitted and absorbed radiative power per unit volume, up to 26,000°K. For Ar, computations are made starting from theoretical values of the material functions G(T), K(T) and the coefficients of emission and absorption to determine the radiative behavior of Ar arc at 1 atm pressure with a channel diameter of 5mm up to 16,000°K. The influence of different assumptions in the theory of emission and the absorption of radiation within the arc are discussed. (auth) (USGRDR)

3330 (AD-690791) FAST BEAM-SWITCHING ELECTRON GUN FOR TRANSIENT BEAM-PLASMA INTERACTION STUDY. Morris, Glen J. (Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.). June 1969. 18p. (D-1-82-871). CFSTI.

An electron gun and deflection system used to study transient beam-plasma interactions is described. The gun produces a 1- or 2-mm diameter beam which can be switched off or on in ~0.5 nsec. Two such guns used in a two-beam device can easily excite large-amplitude plasma oscillations. Measurements of damping in the time domain were made by measuring the damping rate of these oscillations following beam cutoff. (USGRDR) (auth)

3331 (AD-691007) RESEARCH DIRECTED TOWARD EXPERIMENTAL INVESTIGATION OF ELECTROPHORESIS IN PLASMAS. Final Report, May 1, 1966-April 30, 1969. Chanin, Lorne M. (Minnesota Univ., Minneapolis. Dept. of Electrical Engineering). May 1969. Contract AF19(628)-6006. 51p. (AFCRL-69-215). CFSTI.

Results obtained from an experimental investigation of electrophoretic and cataphoretic phenomena in dc discharges are summarized. Electrophoresis studies were conducted on helium, neon, argon, krypton and xenon. Experimental results of the longitudinal pressure gradient when compared with the Leiby-Oskam volume force theory at high pressures and low currents show excellent agreement. Cataphoresis has been investigated experimentally in helium-neon and helium-argon mixtures. For both mixtures, analytic expressions are obtained for the functional dependence of the minority atoms in the axial direction. The analysis which involves the continuity equation takes into consideration the production and loss mechanisms of the minority ions. (auth) (USGRDR)

3332 (MATT-Trans-92) NEW RESULTS IN THE STUDY OF ANOMALOUS PLASMA RESISTANCE IN THE TM-3 TOKAMAK. Bobrovskii, G. A.; Kislyakov, A. I.; Petrov, M. P.; Razumova, K. A.; Shcheglov, D. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Princeton Univ., N. J., from report IAE-1905. 16p. Dep. CFSTI.

An investigation was made of discharge conditions in the TM-3 device with a relatively high temperature and low concentration. Under these conditions protons are detected the temperature of which cannot be explained by Coulomb transfers from electrons to ions in a number of cases. The dependence of the anomalous resistance on certain parameters is studied. (auth)

3333 (NP-tr-1858) INTERACTION OF TWO PLASMA BLOBS IN THE MAGNETIC FIELD OF A DIVERTOR. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Culham Lab., Abingdon, Eng., from report FTI-166. 12p. (CTO-656). Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 23: 36667.

3334 (NP-tr-1859) INTERACTION OF PLASMA FLUXES WITH THE PLASMA CYLINDER IN THE MAGNETIC FIELD OF THE DIVERTOR. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Culham Lab., Abingdon, Eng., from report FTI-169. 10p. (CTO-657). Dep. CFSTI (U. S. Sales Only).

The penetration of the plasma fluxes across the divertor magnetic field into the hollow plasma cylinder formed near the divertor surface from the injected plasma, is investigated with electric probes, a plasmascope, and a Thomson mass spectrograph. It is shown that the leading portions of the plasma fluxes enter the divertor aperture. The tail ends are retarded at the periphery because of their polarization at the plasma cylinder. (auth)

3335 NEUTRAL PARTICLE FLUX MEASUREMENTS IN A PLASMA WIND TUNNEL. Patrick, R. M.; Pugh, E. R.; Jonkman, R. M. (Avco Everett Research Lab., Everett, Mass.). Phys. Fluids, 12: 2323-5(Nov. 1969).

The neutral-particle flux in a plasma wind tunnel was measured using a BeCu detector and found to be less than 1% of the ion density, making it very unlikely that neutrals play an important role in the dissipation processes in the collision-free flow. (auth)

3336 OBSERVATION OF OSCILLATIONS AT THE ION-ION HYBRID FREQUENCIES. Haas, G. M. (Univ. of Houston, Tex.). Phys. Fluids, 12: 2455-8(Nov. 1969).

An instability in a beam-generated plasma column resulted in the observation of oscillations at the ion-ion hybrid frequency. (auth)

3337 DETERMINATION OF LOCAL PLASMA PARAMETERS BY ABSORPTION MEASUREMENTS ON A REFRACTED MICROWAVE BEAM. Dushin, L. A.; Pitkin, V. A.; Skibenko, A. I.; Fomin, I. P. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 348-53(Sept. 1969). Translated from Zh. Tekh. Fiz., 39: 471-7(Mar. 1969).

Experimental determination of the radial distribution of electron density and temperature in the decaying plasma of a pulsed reflex PIG discharge is described. The measurements are based on microwave probing of a plasma cylinder in a transverse cross section at different angles to the discharge surface. (auth)

3338 BRAKING AND PURIFICATION OF A PLASMA JET BY A RAPIDLY INCREASING MAGNETIC FIELD. Vasil'ev, V. I.; Komel'kov, V. S.; Tserevitinov, S. S. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 322-6(Sept. 1969). Translated from Zh. Tekh. Fiz., 39: 438-43(Mar. 1969).

The passage of deuterium plasmoids through a pulsed magnetic field with a mirror geometry is studied using thermal probes and diamagnetic probes, a Thomson mass spectrometer, a monochromator with photomultiplier, etc. It is established that such a field (on the order of 10 to 15 kG) can effectively confine a plasma of density 5 to 20×10^{14} cm^{-3} moving at a velocity of 20 to 6×10^6 cm/sec. By properly choosing the field magnitude and the moment it is switched on one can separate the trailing part of the plasmoid, which is contaminated by impurity ions, from the highly ionized leading edge. Here a mass-spectroscopically pure deuterium plasmoid with a density of $n \sim 2 \times 10^{14}$ cm^{-3} and a velocity of $v = 2 \times 10^7$ cm/sec is obtained. The experimental results are compared with theoretical estimates obtained using the model for plasma interaction with a magnetic field proposed by Artsimovich and Khizhnyak. (auth)

3339 MEASUREMENTS OF THE LONGITUDINAL PRESSURE GRADIENT IN DIRECT-CURRENT DISCHARGES. Bergman, R. S.; Chanin, L. M. (Univ. of Minnesota, Minneapolis). Phys. Fluids, 12: 2348-56(Nov. 1969).

Measurements were made of the longitudinal pressure gradient in dc discharges in helium, neon, and argon. Studies were conducted at current densities ~1 A/cm^2, over a pressure range of approximately two orders of magnitude with an accuracy of $\pm 5\mu$. Present results when compared at high pressures with calculations based on theory indicate good agreement with Leiby and Oskam's theory by comparison with previous theories of the effect. The studies also indicate an anomalous behavior of the gradient at higher discharge currents in neon and argon. (auth)

3340 DECAY OF HIGHLY IONIZED HYDROGEN AND DEUTERIUM PLASMAS. Newton, A. A.; Sexton, M. C. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., B (London), 2: 1069-74(Oct. 1969).

Millimeter microwave interferometers were used to measure electron densities over the range 1.5×10^{14} to 8×10^{11} cm^{-3} in decaying hydrogen and deuterium plasmas without a confining magnetic field, at gas pressures ranging from 5 to 650 mtorr. Variation of the discharge energy input from 8 to 33 mJ cm^{-3} produced a radical change in the afterglow decay of both gases. At the lower energy the decay was controlled by collisional radiative recombination and ambipolar diffusion. However, at the maximum discharge energy of 33 mJ cm^{-3} calculations showed that full ionization was possible below 200 mtorr, indicating that the independence of the decay on density and pressure in both gases below this pressure was due to direct charged-particle expansion to the discharge walls. (auth) (UK)

3341 ELECTRICAL CONDUCTANCE DECAY OF ARC COLUMNS IN SOME COMMON GASES. Jones, G. R.; Edels, H. (Univ. of Liverpool). Z. Phys., 229: 14-32(1969).

Experimental measurements are reported on the conductance decay following current interruption of wall-stabilized arcs in air, nitrogen, argon, oxygen, and helium within the current range 6 to 42 A. Results are compared with the predictions of several analytical models so that the influence of various gas properties and processes may be estimated. Measurements in the molecular gases show clearly how the arc structure affects the recovery. The results in the inert gases differ to some extent from the predictions of the simple models. (auth)

3342 ENHANCED RADIATION TEMPERATURE AT THE ELECTRON PLASMA FREQUENCY IN A NEARLY MAXWELLIAN PLASMA. Skarsgard, H. M.; Stoll, I.; Warnock, A. C. C. (Univ. of Saskatchewan, Saskatoon). Phys. Rev. Lett., 23: 1023-6 (Nov. 3, 1969).

Enhanced radiation temperatures were observed at the plasma frequency in nearly Maxwellian helium-afterglow plasmas. These measurements confirm the predicted bremsstrahlung emission from plasma oscillations generated by suprathermal electrons. (auth)

3343 INTERACTION OF MICROWAVE OSCILLATIONS AND LOW-FREQUENCY OSCILLATIONS IN A BEAM-PLASMA SYSTEM. Levitskii, S. M.; Shapoval, V. Z.; Shashurin, I. P. (Kiev State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 343-7 (Sept. 1969).

Translated from Zh. Tekh. Fiz., 39: 465-70(Mar. 1969).

Parallel observations were made of the microwave and low-frequency oscillation spectra that are usually used to study microwave oscillations appearing in the presence of interaction of the electron beam with the plasma created by that same beam. By observing the interaction of the isolated frequencies, it was demonstrated that such interaction between different parts of the spectrum actually exists and can lead to the establishment of a single "self-consistent" spectrum whose perturbation in some part of the spectrum is reflected in the form of the spectrum in very remote parts. (M.O.W.)

3344 PLASMA CAMERA OBSERVATIONS OF ELECTRIC AND PRESSURE DRIFTS AT THE EDGE OF A LOW-β PLASMA. Cataldo, Joseph C. (The City Univ. of New York, N. Y.). Phys. Fluids, 12: 2459-61(Nov. 1969).

Plasma camera photographs show $E \times B$ driven irregularities rotating around the edge of the plasma column. Placing an artificial boundary in the core of the plasma column results in a pressure gradient that will drive the plasma in the $-\nabla p \times B$ direction. (auth)

3345 SOME FEATURES OF A PLASMA BEAM PRODUCED BY A HF SLOTTED LINE AND TRAPPED IN A NONHOMOGENEOUS MAGNETIC FIELD. Fontanesi, M.; Sindoni, E. (Univ., Milan). Nuovo Cim., 64B: 88-102(Nov. 11, 1969).

The characteristics of a plasma beam created by means of a slotted line with hf power in a magnetic mirror were studied in the range of neutral-gas pressure between 3×10^{-6} and 10^{-3} mm Hg. The radial and axial profiles of the electron density and temperature, of the floating potential, and of the ion density are reported. It was found that at the lowest pressures the random energy of the electrons is transformed in axial energy of both electrons and ions. (auth)

3346 SELF-FOCUSING AND PLASMA FORMATION IN TRANSPARENT MEDIA. Engelhardt, Wolfgang (Institut fuer Plasmaphysik, Garching, Ger.). Appl. Phys. Lett., 15: 216-7 (Oct. 1, 1969).

On focusing a laser beam on transparent materials, luminous channels within the media were observed, which were attributed to two effects. The beam is first self-focused because of nonlinearity of the material, and breakdown occurs. A second self-focusing effect is then possible in the plasma so produced. Divergence of the beam is prevented, and further heating occurs. (auth)

3347 INVESTIGATION OF THE "ANOMALOUSLY" ACCELERATED MOTION OF IONS IN A GAS UNDER THE ACTION OF A VARYING ELECTRIC FIELD. Pasechnik, L. L.; Yagola, V. V. (Inst. of Physics, Kiev). Zk. Eksp. Teor. Fiz., 57: 1086-9 (Oct. 1969). (In Russian).

Results are presented of an experimental investigation of the effect of a nonuniform alternating (sinusoidal) electric field on the motion of ions in a gas across a magnetic field. It is shown that the electric field has an "anomalously" strong effect on the time of motion of the ions. The existence of "collision resonance" is established. The essence of this phenomenon is that, for a certain relation between the frequency of collisions between ions and atoms and the electric field frequency, the effect of the latter is maximal. (auth)

3348 INVESTIGATION OF ELECTRON RECOMBINATION IN INERT GASES. Dolgov-Savel'ev, G. G.; Knyazev, B. A.; Koz'minykh, Yu. L.; Kuznetsov, V. V. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zk. Eksp. Teor. Fiz., 57: 1101-8(Oct. 1969). (In Russian).

Recombination of electrons in inert gases at pressures up to 150-mm Hg is investigated. The plasma was produced either by a 600-keV electron beam or by a rapid straight discharge. An ultrahigh frequency and optical methods were employed for determining the decrease of the electron density in time. It was found that the electron recombination rate depends on how the plasma was "prepared" or, more precisely, on its degree of ionization and on the initial electron temperature. In lighter atomic gases, the increase of the recombination rate was much greater if the plasma was produced by an electron beam. Apparently, dissociative recombination should be considered the main mechanism responsible for the drop of the electron concentration. (auth)

3349 MEASUREMENTS OF PARAMETERS OF NONEQUILIBRIUM CESIUM PLASMA. Kiryushchenko, A. I.; Lebedev, M. A.; Maev, S. A.; Morozova, G. G.; Privalov, I. N.; Smirenkina, I. I. Zh. Prikl. Spektrosk., 11: 392-5(Sept. 1969). (In Russian).

Electron distribution functions and the population of excited atomic levels in a short low-voltage cesium arc discharge were measured. The measurements indicated that, at certain conditions, the distribution function can be observed with saturation or deficiency of fast electrons. Analyses of the electron distribution function are given in graphical and tabulated forms. (R.V.J.)

3350 GENERATION OF COHERENT RADIATION OF OPTICAL RANGE IN PLASMA-BEAM DISCHARGE. Tkach, Yu. V.; Fainberg, Ya. B.; Bolotin, L. I.; Bessarab, Ya. Ya.; Gadetskii, N. P.; Magda, I. I.; Bogdanovich, A. V.; Chernen'kii, Yu. N. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 1470-5(Sept. 1969). (In Russian).

An investigation was made of laser generation with wave length 4880 Å on high-temperature argon plasma. In plasma-beam

discharge, induced by high-speed electron beams traversing the neutral gas, the plasma electron energies are about 80 eV and the plasma electron density is 10^{13} cm^{-3} due to the plasma instability. There are two regimes of generation depending on the argon pressure. The first regime is conditioned by the inversion by fast electrons and is described by the sudden perturbations. The second regime is conditioned by the step population of higher generating level when the slow electrons collide with argon ions. The length and the output power of laser impulse differ in both cases; in the first regime the generating time is 16 μsec and the peak power is 100 W; in the second regime, 65 μsec and 6 W, correspondingly. (auth)

3351 VYSOKOTEMPERATURNAYA TEPLOFIZIKA. (High-Temperature Thermal Physics). Lykov, A. V. Moscow, Izdatel'stvo Nauka, 1969. 128p.

Nine articles are included on electric discharges and heat exchange in generators of low-temperature plasma. Problems of diffusion decay in recombining plasma and asymptotic regularities of decay in space-inhomogeneous isothermal plasma at various physical conditions are discussed in the first three articles. Several articles are devoted to the heat exchange of solids with a flux of high-enthalpy gas. Arc discharges between coaxial electrodes under low magnetic pressure and problems related to discharges in low-temperature plasma are also discussed. The last four articles cover the method for determining thermophysical properties of materials at high temperatures, thermal conductivity of binary gas mixtures, and determination of copper concentration in plasma jets. (R.V.J.)

Kinetics (Theoretical)

3352 (CONF-690803-31) STOCHASTIC PROCESSES IN PLASMA. Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 111p. (In Russian and English). Dep. CFSTI (U. S. Sales Only).

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The following topics are discussed: (1) the spectrum of plasma turbulence, (2) correlation of stochastic fields—turbulent and stochastic heating, (3) stochastic acceleration of particles, (4) radiational turbulence and the cosmic-ray problem, and (5) penetration of electromagnetic perturbations in turbulent plasma and the second sound in plasma. (M.O.W.)

3353 (JINR-P4-4647) PECULIARITIES OF THE SHORT-WAVE PART OF THE DOPPLER SPECTRUM IN A MEDIUM. Frank, I. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 14p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The Doppler effect in a refractive medium is considered. Attention is focused on the peculiar features of the Doppler spectrum in the region of frequencies exceeding the plasma frequency of the medium. (auth)

3354 (N-69-35036) SOME CONSEQUENCES OF ROTATION IN THETA-PINCH-GENERATED PLASMA CONFINED BY A LONGITUDINAL MAGNETIC FIELD. Stainer, Howard M. (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Mar. 1969. 71p. (AD-688442; APL-TG-1059). CFSTI.

A theoretical study was made of the characteristics of structured plasma puffs produced in a two-coil theta-pinch gun. The puffs are fired into a drift tube containing a longitudinal magnetic field, and their subsequent behavior is analyzed. Electron–electron and ion–ion collision times are short enough so that scalar pressures (P = nkT) can be used. Ion–electron collision times, however, are of the duration of the experiment or longer, allowing the use of two-fluid moment equations. An idealized model for the plasma puffs is proposed in which the ion fluid rotates as a rigid body in one direction about the longitudinal axis, and the electron fluid rotates in the opposite direction. This high-β model yields self-consistent equilibrium density and magnetic field profiles, stemming from a balance among thermal, magnetic, centrifugal, and electrostatic forces, that are compatible with observation. It is shown that double magnetic pickup loop signals can be analyzed to ascertain the temperature, peak density, angular momentum, etc., of the plasma as it travels down the tube, and a sample calculation is presented to indicate the probable evolution of a typical puff. Thus, the model provides a self-consistent high-β approach to the problem of plasma and magnetic-field interaction. (auth) (STAR)

3355 (ORNL-4406(Pt.1)) REVISED FORMULATION OF THE MACROSCOPIC MAXWELL THEORY. I. FUNDAMENTALS OF THE PROPOSED FORMULATION. Neufeld, Jacob (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 33p. Dep. CFSTI.

A modified version of the macroscopic Maxwell theory is developed with the purpose of removing some of the current contradictions and inconsistencies. One of the crucial problems of the current electromagnetic theory concerns the concept of energy. It appears that energy, which has a clearly defined physical significance in all fields of physics, has not been properly incorporated into the Maxwell–Lorentz theory. Therefore, the electromagnetic energy in a dissipative system as interpreted in the current version of the theory is not "energy" in the same sense as one usually interprets this concept in classical mechanics. The main object of this investigation is, therefore, to clarify the meaning of energy and to suggest a revised version in which the concept of energy is incorporated in accordance with the logical requirements of the theory. The proposed version is based on an assumption that the "electrical energy" both in nondissipative and dissipative media has a meaning only to the extent to which the electric-field theory can be developed as a theory of a dynamical system. This assumption leads to a formulation of a principle which states that the energy density U_e of an electrical field in an absorbing medium is determined solely by the electrical intensity E and is, therefore, independent of any parameter which represents absorption. The proposed version differs from the traditional theory in the interpretation of the dielectric constant and of conductivity. The dielectric constant is considered to be independent of conductivity in the sense that a change in conductivity does not produce a corresponding alteration of the dielectric constant. Part I of this investigation deals with the fundamentals of the proposed reformulated version. These fundamentals are then applied in Part II to the extension of Brillouin's theory of wave propagation and group velocity to absorbing media. (auth)

3356 (ORNL-4406(Pt.2)) REVISED FORMULATION OF THE MACROSCOPIC MAXWELL THEORY. II. PROPAGATION OF AN ELECTROMAGNETIC DISTURBANCE IN DISPERSIVE MEDIA. Neufeld, Jacob (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 25p. Dep. CFSTI.

The theory of energy propagation in dispersive media formulated by Brillouin is generalized and extended by taking into account energy attenuation or energy growth during the transmission process. Because of the exponential decay due to attenuation, the concept of propagation velocity of an electromagnetic disturbance can now be shown to have a physical meaning, even if there is absorption, and in such case the velocity of the disturbance is represented by the velocity of the point at which it attains its maximum intensity. Expressions are obtained for the energy density and the energy flow in an absorbing medium, and it is shown that the propagation velocity (a kinematic concept) is equal to the velocity of the energy transport. Such an equality is considered to be of fundamental interest, since it supports the validity of the kinematic approach from the energetic point of view. Other aspects of energy transmission are discussed and analyzed, with particular references to nonconvective and convective disturbances in absorbing and emitting media. (auth)

3357 NUMERICAL SIMULATION OF WARM TWO-BEAM PLASMA. Morse, R. L.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 12: 2418-2418-25(Nov. 1969).

One-dimensional numerical simulation of plasmas consisting of two unequal warm beams has shown flattening of the small beam and, in most cases, a strong single mode structure of about the wavelength of largest linear growth rate, accompanied by an eddylike arrangement of trapped particles in phase space. The total electrostatic field energy first increases at the linear growth rate and then, after saturating abruptly, decreases at about the same rate to an intermediate level where a much slower decay begins. (auth)

3358 MAGNETIC FIELD CORRECTIONS TO THE PLASMA BREMSSTRAHLUNG SPECTRUM. Pytte, Agnar; McBride, John B. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 12: 2458-9 (Nov. 1969).

The bremsstrahlung emitted in a Maxwellian plasma in a constant magnetic field is calculated. It is assumed that the wave frequency ω is large compared with the plasma frequency ω_p and the electron cyclotron frequency Ω_e. (auth)

3359 AXIAL PRESSURE GRADIENT IN DIRECT-CURRENT DISCHARGES. Oskam, H. J. (Univ. of Minnesota, Minneapolis). Phys. Fluids, 12: 2449-51(Nov. 1969).

The axial pressure gradient in dc discharges due to the previously reported volume force on the neutral particles is calculated both for closed and by-pass systems assuming laminar gas flow. (auth)

3360 VELOCITY MOMENTS OF THE LINEARIZED VLASOV EQUATION. Dorman, G. (Polytechnic Inst. of Brooklyn, N. Y.). Phys. Fluids, 12: 2451-4(Nov. 1969).

Using a recently obtained self-consistent solution of the Vlasov–Poisson equations for inhomogeneous plasmas, the velocity moments of the Vlasov equation are calculated to first order in temperature. (auth)

3361 QUANTUM-MECHANICAL PLASMA TRANSPORT THEORY. Williams, R. H.; DeWitt, H. E. (Univ. of California, Livermore). Phys. Fluids, 12: 2326-42(Nov. 1969).

The quantum-mechanical convergent kinetic equation of Gould and DeWitt is used for the calculation of static transport coefficients through first order in the plasma parameter for a fully ionized, nondegenerate, two-component plasma near thermal equilibrium. The equation is solved with the standard Chapman–Enskog procedure using a three-term Sonine polynomial expansion. Since close collisions and dynamic screening effects are treated correctly, the results contain both logarithmic (dominant) and nonlogarithmic (subdominant) terms evaluated exactly to first order in the plasma parameter. Since close collisions are treated quantum mechanically the transport coefficients obtained are valid for a wide range of temperatures. For the case where only one Sonine polynomial is used in the evaluation of the electrical conductivity, the result obtained here reduced to that of Kivelson and DuBois in the high-temperature limit ($kT \gg Ry$) and to that of Gould and DeWitt in the low-temperature, classical limit ($kT \ll Ry$). Using more than one Sonine polynomial in the expansion of the distribution function, one obtains for the electrical conductivity $\sigma(\xi) = c(\xi)\sigma(1)$, where ξ is the number of terms in the Sonine expansion and $\sigma(1)$ is the result for one term. In the limit where the Coulomb logarithm is large, $c(3) = 1.95$ and $c(\infty) = 1.973$, so that our results are accurate to 1 or 2% for a wide range of temperature (including $kT \sim Ry$). (auth)

3362 CHARGE SEPARATION EFFECTS IN THE CHAPMAN–FERRARO–ROSENBLUTH COLD PLASMA SHEATH MODEL. Murphy, Brian L. (Mt. Auburn Research Associates, Inc., Cambridge, Mass.). Phys. Fluids, 12: 2381-7(Nov. 1969).

The boundary layer between a cold streaming plasma and a perpendicular magnetic field is treated for the case where significant charge separation effects occur and the electrons but not the ions are relativistic. This case is characterized by $1 \lesssim \gamma \ll M/2m$, where $\gamma = Mu^2/2mc^2$ is the ratio of the initial ion streaming energy to the electron rest energy. Only the over-all charge neutral boundary layer in which the electrons turn in the magnetic field before the ions is considered. It is found that the length scale of the magnetic field before the electron turning point is the plasma skin depth c/ω_{pe} as in the boundary layer with $\gamma \ll 1$, but that the electron number density diverges near the turning point with a length scale at least u/c smaller. For large γ the fraction of the ion streaming energy gained by the electrons as kinetic energy is approximately $(2/\gamma^2)^{1/3}$, and the ions are found to penetrate a distance somewhat less than $(\sqrt{2}/3)(u/\omega_{pi})$ beyond the electrons. (auth)

3363 THEORY OF THE ELECTRODE SHEATH IN A LOW-TEMPERATURE PLASMA. Baksht, F. G.; Moizhes, B. Ya.; Nemchinskii, V. A. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 417-23(Sept. 1969). Translated from Zh. Tekh. Fiz., 39: 558-66(Mar. 1969).

Plasma contact with nonemitting electrodes was investigated for the case in which the barrier retards electron motion from the plasma to the electrode and the electron temperature is much greater than the atom temperature. The sheath is divided into two regions, quasi-neutral and space-charge. The first region is solved independently of the parameters of the ion kinetic equation and the distributions of potential and charged-particle density are determined. In the space-charge region, the Poisson equation is solved. It is shown that the inclusion of collisions in the space-charge sheath always gave a monotonic distribution of potential, field strength, charged-particle density, etc., in the sheath. (auth)

3364 QUADRATIC RESPONSE FUNCTIONS AND TRIPLE CORRELATIONS IN PLASMAS. Silevitch, M. B.; Golden, K. I. (Brandeis Univ., Waltham, Mass.). Nuovo Cim., 63B: 486-96(Oct. 11, 1969).

Definitions of and relations among quadratic plasma response functions are established from Maxwell's equations and nonlinear constitutive relations. Then from statistical mechanical perturbation theory, equilibrium triple correlations of the microscopic charge density are expressed in terms of these response functions. (auth)

3365 MOTION OF A CHARGED PARTICLE IN SUPERPOSED HELIOTRON AND BICONICAL CUSP FIELDS. Srivastava, M. P.; Bhat, P. K. (Indian Inst. of Science, Bangalore). J. Plasma Phys., 3: 255-67(May 1969).

The behavior of a charged particle in an axially symmetric magnetic field having a neutral point is studied so as to find a possibility of confining a charged particle in a thermonuclear device. In order to study the motion a three-dimensional motion was reduced to a two-dimensional one by introducing a fictitious potential. Following Schmidt, the motion was classified as an 'off-axis motion' and an 'encircling motion,' depending on the behavior of this potential. It is shown that the particle performs a hybrid type of motion in the negative z axis, i.e., at some instant it is in 'off-axis motion' while at another instant it is in 'encircling motion.' The equation of motion was solved numerically and the graphs of the particle trajectory verify the analysis. It was found that in most of the cases the particle is contained. The magnetic moment is found to be moderately adiabatic. (auth) (UK)

3366 INFLUENCE OF NATURAL RADIAL CONVECTION UPON THE TRANSIENT BEHAVIOUR OF A CYLINDRICAL ARC COLUMN. Jones, G. R.; Freeman, G. H. (Liverpool Univ.). Z. Phys., 229: 177-91(1969).

An analytical model is proposed that describes the general transient behavior of a cylindrical arc column subjected to the influence of a self-generated radial convection. The model, in conjunction with data for real gases, yields a criterion for assessing the importance of radial convection in various transient arcs, and allows the influence of a variable diffusivity to be determined. In the case of a freely recovering column, having a constant diffusivity within its electrical conduction zone, the radial convection merely modifies the column time constant, whereas for a variable diffusivity the column decay becomes nonexponential at later times during the recovery. (auth)

3367 TRANSFORMATION OF WAVES AND ELECTRON HEATING IN A RADIALLY INHOMOGENEOUS PLASMA. Kopecky, V.; Preinhaelter, J.; Vaclavik, J. (Inst. of Plasma Physics, Prague). J. Plasma Phys., 3: 179-88(May 1969).

The propagation and linear transformation of high-frequency electrostatic waves in a hot magnetoactive plasma with radially decreasing density is investigated. It is shown that in the region of the hybrid resonance cold plasma waves with a long wavelength are transformed into the Bernstein modes with a short wavelength. By this shortening of the wavelength the absorption of the waves increases, particularly for the frequencies near the electron cyclotron harmonics. It might be the cause of the electron heating in plasma–beam experiments. (auth) (UK)

3368 MORE-UNIFORM PERTURBATION THEORY OF THE VLASOV EQUATION. Lewak, G. J. (Univ. of California, San Diego, La Jolla). J. Plasma Phys., 3: 243-53(May 1969).

The Vlasov–Poisson equations are reformulated by applying an arbitrary transformation to the velocity variable in such a way that perturbation theory of the transformed equations does not exhibit the customary secularity in time (or space) in second or higher order. The lowest order approximation of the new formulation is discussed and compared with conventional results. The source of the nonuniformity appears to be the divergence of particle trajectories as calculated by perturbation methods, from the exact ones after long times. The transformation which allows one to follow the particle trajectories is a transformation to a frame of reference moving with a plasma test particle in the self-consistent field. (auth) (UK)

3369 ELECTRON DISTRIBUTION FUNCTION OF A LORENTZIAN PLASMA CROSSED BY A PROGRESSIVE TRANSVERSE WAVE. Molinet, Frederic (Institut Henri Poincare, Paris). Compt. Rend., Ser. B, 269: 237-40(Aug. 4, 1969). (In French).

The existence and uniqueness of the solution of the Boltzmann equation for the electron distribution function of a Lorentzian plasma crossed by a progressive transverse wave are demonstrated in the case where all constituents of the gas are in Maxwellian equilibrium before the passing of the wave. (tr-auth)

3370 STUDY OF ELECTRIC ARC MOTION IN A DISCHARGE CHAMBER OF A PLASMA GENERATOR. Shaboltas, A. S. (Minsk Inst. of Heat and Mass Exchange). Inzh.-Fiz. Zh., 17: 570-4(Sept. 1969). (In Russian).

The velocity of high-current streamlined electric arc in a discharge chamber of a coaxial sectionized plasma generator was experimentally studied. A relationship was established describing the dependence of the cathode spot velocity on the arc current intensity and strength of the external magnetic field. (auth)

3371 ON THE POSSIBILITY OF EXISTENCE OF A STRONGLY NONIDEAL PLASMA. Rakhimov, A. T.; Ulinich, F. R. (Inst. of Nuclear Physics, Moscow). Zk. Eksp. Teor. Fiz., 57: 1425-30(Oct. 1969). (In Russian).

The properties of a strongly nonideal plasma ($\gamma \gg 1$) are considered. It is shown that in the "gas" region of densities and temperatures of any substance (the density is smaller than the solid-body value), for which extrapolation of the theory of an ideal plasma predicts strong nonideality, two thermodynamic equilibrium

states of matter should be possible. In one, two phases of different density should coexist; in one of these the matter is an ideal plasma and in the other the plasma density is close to that of a solid body. In the second state, the matter is a homogeneous plasma with an ionization equation $n_e = (T/e^2)^3$. It is pointed out that, in principle, the existence of a homogeneous strongly nonideal electron–ion plasma should be possible at matter densities close to the solid-body values. (auth)

3372 QUASI-LINEAR RELAXATION OF AN ELECTRON BEAM IN AN INHOMOGENEOUS FINITE PLASMA. Breizman, B. N.; Ryutov, D. D. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zk. Eksp. Teor. Fiz., 57: 1401-10(Oct. 1969). (In Russian).

The influence of plasma inhomogeneities on the solution of the stationary boundary problem concerning the interaction between an electron beam and a plasma is investigated. It is shown that inhomogeneity leads to two important effects. First of all, if the plasma contains a region in which the concentration increases along the direction of motion of the beam, then quasi-linear relaxation should cause the appearance of accelerated electrons. secondly, quasi-linear relaxation in an inhomogeneous plasma is much less rapid than in a homogeneous one (in the absence of "trapped" oscillations). (auth)

3373 GENERATION OF LONGITUDINAL WAVES WITH COMBINED FREQUENCIES IN A BEAM–PLASMA SYSTEM. Rabinovich, M. I.; Fainshtein, S. M. (Gorky State Univ., USSR). Zk. Eksp. Teor. Fiz., 57: 1298-1305(Oct. 1969). (In Russian).

It is shown that production of the second harmonic of the plasma frequency should be possible in a beam–plasma system. This is due to nonlinear interaction between the quasi-harmonic wave, increasing as a result of beam instability, and the higher-frequency longitudinal waves synchronous with the wave. A consequence of this generation is restriction of the growing-wave amplitude, i.e., dynamic stabilization of the beam instability. Three- and two-wave processes occurring at various relative densities of the beam and plasma electrons are considered. It is found that, for stability of the respective equilibrium processes, sufficiently frequent collisions in the plasma are necessary. The analogous problem in nonlinear optics is discussed. The analysis is carried out for a single-velocity beam and a cold, strongly magnetized plasma in the quasi-hydrodynamic approximation. Estimates are made which show that observation of the effects under laboratory conditions should be feasible. (auth)

3374 NONADIABATIC PARTICLE BEHAVIOR IN NON-UNIFORM ELECTROMAGNETIC FIELDS. Canobbio, E. (EURATOM–CEA, Gif-sur-Yvette, France). Nucl. Fusion, 9: 267-9(Oct, 1969).

New adiabatic invariants which exist in the presence of a resonant field are discussed. The asymptotic theory of nonlinear oscillation is used to discuss resonant particle orbits. Nonadiabaticities due to static or slowly varying configurations and the effect of stochastic and short wave-length electromagnetic fields are described. (M.O.W.)

3375 MODEL FOR THE DERIVATION OF KINETIC THEORY. Ramanathan, G. V. (Courant Inst. of Mathematical Sciences, New York); Sandri, G. J. Math. Phys. (N. Y.), 10: 1763-73(Sept. 1969).

A soluble model for the derivation of kinetic theory is discussed. It is shown that Bogolyubov's adiabatic assumption is not valid even to leading order in the kinetic regime. Furthermore, the adiabatic assumption gives rise to a singular behavior in the correlation function which is sufficiently strong to violate the ordering assumed in the expansion. The exact result for the model correlation is neither adiabatic nor singular throughout the kinetic regime. One shows that the singularity is removed by properly reordering the correlation in the relevant domains; then a method for obtaining uniformly valid asymptotic solutions for a wide class of integrodifferential problems is presented. The technique is applied to the BBGKY hierarchy and it is shown that for a weakly coupled gas (i) the familiar Landau equation is satisfied in lowest order by the velocity distribution function and (ii) the two-particle correlation function can be calculated consistently to leading order, yielding a nonadiabatic and nonsingular behavior. (auth)

3376 ELECTROSTATIC WAVE PROPAGATION AND AMPLIFICATION IN AN ELECTRON BEAM–INHOMOGENEOUS PLASMA SYSTEM CONFINED BY A MAGNETIC FIELD. Weinfeld, Michel; Bouchoule, Andre (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. B, 269: 305-8(Aug. 18, 1969). (In French).

A linear theory is presented for electrostatic wave amplification in a homogeneous electron beam--radially inhomogeneous plasma system confined by an infinite magnetic field. The properties of the rotationally directed modes are studied. With conditions in which an amplification is obtained, the equiphase surfaces of these modes are no longer right-section planes. On the other hand, in the case of an inhomogeneous plasma only, in which there is no amplification, these surfaces are right-section planes. (tr-auth)

3377 LOW-FREQUENCY INSTABILITY OF SLIDING ION BEAMS IN MAGNETIC FIELD. Goncharov, A. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 14: 1430-3(Sept. 1969). (In Russian).

It is shown that in the system of sliding cylindrical symmetric (coaxial) ion beams (streams of plasma) moving along the magnetic field to meet each other, a low-frequency "sliding" instability of long-wave oscillations of "surface waves" type takes place. It is due to the change (tangential rupture) of speed on the boundary of beams. The boundary of this instability, as to the velocities, can be much higher than the boundary of double-beam ion instability. (auth)

3378 RELAXATION TIME OF HIGH-DENSITY ELECTRONS. Andreev, V. V. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 1434-43(Sept. 1969). (In Russian).

High-frequency electric conductivity of a degenerate Fermi gas of high-density electrons in homogeneous fields is calculated by means of the Kubo general formula and quantum field theory. Electron scattering by ions is taken into account in the second-order perturbation theory, the Coulomb potential being screened. Two cases are considered: (1) the ions vibrate harmonically; (2) the ions form a Boltzmann gas. The dependence is obtained of electron relaxation time τ on temperature and frequency ω of the field in the frequency range $\omega\tau \gg 1$. (auth)

3379 EIGENFUNCTIONS OF THE LINEARIZED VLASOV–BGK OPERATOR. Vojta, G.; Mocker, M. (Arbeitsstelle fuer Statistische Physik, Leipzig. Humboldt-Univ. Berlin). Phys. Lett., 30A: 303-4(Nov. 3, 1969).

The initial value problem for the linearized Vlasov equation supplemented by complete Bhatnagar–Gross–Krook collision integrals is solved exactly by the method of singular eigenfunctions. The system considered is a nonrelativistic nondegenerate electron gas with neutralizing ion background and without magnetic field. (auth)

3380 EXTENDED RING SUMMATION FOR A CLASSICAL ELECTRON GAS. Kutty, A. P. G.; Khubchandani, P. G. (Bhabha Atomic Research Center, Bombay). Progr. Theor. Phys. (Kyoto), 42: 143-5(July 1969).

The method of irreducible cluster expansion was used for calculating the free energy and related properties of liquids and gases. In particular, systems of particles interacting via a Coulomb potential such as the electron gas and high-temperature plasma have been studied. A brief review of the theory is given. (M.O.W.)

3381 TURBULENCE IN A RAREFIED PLASMA. Tchen, C. M. (National Bureau of Standards, Washington, D. C.). pp 689-92 of Fluid Dynamics Transactions. Vol. 3. Fiszdon, W.; Kucharczyk, P.; Prosnak, W. J. (eds.). Warszawa, Panstwowe Wydawnictwo Naukowe, 1967.

From Symposium on Advanced Problems and Methods in Fluid Dynamics, Jurata, Poland. See CONF-650933.

It is concluded that the expression for total damping consists of a laminar damping, i.e., linear Landau damping, and a turbulent damping, which depends on the amplitudes. It is noted that the present method of the derivation of the decay of the electric energy gives the damping coefficient in a simple and direct manner, without involving the eigenvalue calculations. Correlation functions in a turbulent plasma are included in an appendix. (M.H.R.)

Production

Refer also to abstracts 3298 and 3345.

3382 MICROWAVE FORMATION AND HEATING OF PLASMAS FOR CONTROLLED FUSION RESEARCH. Eason, H. Odell Jr. (Oak Ridge National Lab., Tenn.). J. Microwave Power, 4: 88-99(1969).

Stable high-density, high-temperature deuterium plasmas are formed at 10^{-5} torr pressure within a multimode cavity located in a magnetic confining field by application of high-power c-w microwaves at the electron gyrofrequency. The method, equipment considerations, and present trends are discussed. (auth)

Stability

Refer also to abstract 3418.

3383 (AD-692193) COLLISIONAL DRIFT-LIKE INSTABILITY OF A WEAKLY IONIZED MAGNETOPLASMA WITH NO AXIAL DRIFT. Mumola, Peter B.; Powers, Edward J. (Texas

Univ., Austin, Electronics Research Center). May 15, 1969. 67p. (TR-64; AFOSR-69-1145-TR). CFSTI.

Results of a theoretical and experimental study of the stability of inhomogeneous weakly ionized magnetoplasmas with no axial drift are reported. A linearized two-fluid hydrodynamic stability analysis yields a dispersion relation that is analyzed numerically. Oscillations with an azimuthal phase velocity approximately equal in magnitude and in the same direction as the electron diamagnetic drift are predicted to become unstable (onset) once the external magnetic field exceeds some critical value. This instability was observed experimentally in a capacitively coupled rf discharge immersed in a static, uniform magnetic field. The rf discharge was utilized in order to simulate a plasma with no applied axial drift of particles. Stability criteria are displayed graphically in terms of the magnetic field strength, neutral gas pressure, and discharge tube radius. Experimental measurements are found to be in excellent agreement with the predicted values of critical magnetic field and phase velocity over a wide range of neutral gas pressures and several different discharge tube radii. The parameters dependence (on pressure and magnetic field) of both the theoretically predicted and experimentally measured phase velocity is similar to that expected for a drift wave. For this reason the instability is referred to as a drift instability. (auth) (USGRDR)

3384 (INR-P-1056) CONVECTIVE AND ABSOLUTE TWO STREAM INSTABILITIES FOR HOT PLASMAS. Infeld, E.; Skorupski, A. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 8p. (CONF-690619-14). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

The problem of stability for two streams of hot, charged particles in the resonance model are resolved. The instabilities are then classified into absolute and convective. (auth)

3385 (MATT-730) DEVELOPMENT OF COLLISIONAL-DRIFT-WAVE TURBULENCE. Hendel, H. W.; Chu, T. K. (Princeton Univ., N. J. Plasma Physics Lab.). Oct. 1969. Contract AT(30-1)-1238. 6p. (CONF-690923-2). Dep. CFSTI.

From International Conference on Physics of Quiescent Plasmas, Paris, France.

The development of collisional drift-wave turbulence in the far unstable regime, $B \gg B_c$, is studied in a lithium Q-machine plasma. For this low ion mass the magnetic field covers a range up to $B = 10\ B_c$ in the relevant density ($\sim 10^{11}$ cm^{-3}) and temperature (~2800°K) ranges. At the highest magnetic field, B = 6500 Gauss, the ratio of plasma radius to ion Larmor radius is approximately 60. The results are discussed. (M.O.W.)

3386 (MATT-731) SOFT- AND HARD-ONSET AND AMPLITUDE SATURATION OF COLLISIONAL DRIFT INSTABILITIES. Chu, T. K.; Hendel, H. W.; Schlitt, L. G.; Simonen, T. C.; Stix, T. H. (Princeton Univ., N. J. Plasma Physics Lab.). Oct. 1969. Contract AT(30-1)-1238. 8p. (CONF-690923-1). Dep. CFSTI.

From International Conference on Physics of Quiescent Plasmas, Paris, France.

Measurements are reported of the onset of low azimuthal modes and of the amplitude behavior for the collisional drift instability in Q-machine alkali-metal plasmas, together with an interpretation based on mode-coupled Landau-type master equations. (M.O.W.)

3387 (NP-tr-1855) INFLUENCE OF ELECTRICAL CONDUCTIVITY ON THE EQUILIBRIUM OF LOW PRESSURE PLASMAS IN STELLARATORS. Pfirsch, D.; Schlueter, A. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Translated for Culham Lab., Abingdon, Eng., from report MPI/PA-7/62. 14p. (CTO-562). Dep. CFSTI (U. S. Sales Only).

In the case of finite electric conductivity of the plasma there are no static but only stationary equilibria in stellarators. The fluxes occurring in such configurations, the associated diffusion and the electric fields are calculated on the basis of a simple model; the duration of the acceleration necessary to reach the flow velocities is estimated. The general results are these: the diffusion exceeds the normal diffusion by a factor $8\pi^2/\iota^2$, where ι is the rotational transform of the magnetic field; in high-density low-temperature plasmas the duration of the acceleration process may be so large that the plasma hits the wall before reaching equilibrium. This might explain certain experiments by Remy, Lotz and Wolf. (auth)

3388 (ORNL-TM-2766) STABILITY OF TOKAMAKS. Harris, Edward G. (Oak Ridge National Lab., Tenn. Tennessee Univ., Knoxville). Oct. 16, 1969. 21p. Dep. CFSTI.

Following a conjecture by Morse and Freidberg, the stability of the Bennett pinch was investigated with a magnetic field parallel to the axis. One found reason to believe that under certain conditions all instabilities may be eliminated except for localized MHD instabilities near the axis. According to a modified form of the Suydam criterion derived here, these MHD instabilities are eliminated when the cylindrical Bennett pinch is bent into a torus if β_z, and the toroidal β is less than $(^6/_4)(r_0/R)^2$, where r_0 is the mean radius of the pinch and R is the major radius of the torus. It is suggested that Tokamaks may operate in this stable regime. (auth)

3389 (UCRL-Trans-10378) DISSIPATIVE TRAPPED-PARTICLE INSTABILITY IN A DENSE PLASMA (COLLECTION). Kadomtsev, B. B.; Pogutse, O. P. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated for Univ. of California, Lawrence Radiation Lab., Livermore, from report IAE-1861. 39p. (CONF-690619-11; CONF-690619-12; CONF-690619-13). Dep. CFSTI.

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

This collection consists of three papers on the drift-wave instability associated with the dissipation occurring when trapped electrons are converted into transit electrons and vice versa. The first paper investigates the instability itself, the second paper shows that, in some cases, the growth of drift waves may result from electrical capture of electrons by the wave and, finally, the third paper analyzes the laminar convection in toroidal systems due to trapped-electron instabilities. (auth)

3390 STABILITY OF THE DENSE PLASMA FOCUS. Mather, Joseph W.; Bottoms, Paul J.; Carpenter, James P.; Williams, Arthur H.; Ware, Kenneth D. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 12: 2343-7(Nov. 1969).

The influence of small dc axial magnetic fields on the stability of the focused plasma column is shown in the light of soft x rays. The material damage to the center electrode and the intense x-ray emission at the electrode face as a result of electron bombardment is considerably reduced. Although the final heating of the ions and electrons is inhibited as expected due to a trapped magnetic field, the spatial stability of the focused column offers a greater possibility for scaling to higher energies. (auth)

3391 DRIFT-WAVE FLUCTUATIONS AND ANOMALOUS DIFFUSION IN A FULLY IONIZED CESIUM PLASMA. Walsh, J.; Schlesinger, S. P.; Josephy, K.; Marshall, T. C. (Columbia Univ., New York). Phys. Fluids, 12: 2374-80(Nov. 1969).

An experimentally determined diffusion coefficient is related to the amplitude of a continuum spectrum of drift-wave-like fluctuations. It is found that the diffusion coefficient depends upon the amplitude of the fluctuation in a way which is consistent with the nonlinear diffusion theory of Dupree; that is, $D_\perp \sim \langle \delta n^2 \rangle$ for small amplitude and $\sim \langle \delta n^2 \rangle^{1/2}$ for large amplitude. An elementary model which predicts the relative fluctuation amplitude $\langle \delta n^2 \rangle / n_0^2$ and the autocorrelation time of the continuum spectrum of driftlike waves is also presented and shown to be in agreement with both the properties of the observed spectrum and the results of the diffusion measurements. (auth)

3392 NONLINEAR FLUTE INSTABILITIES INHERENT IN TWO-COMPONENT PLASMAS. Manheimer, Wallace M. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 12: 2395-2405(Nov. 1969).

It is shown that a cold plasma in a weak magnetic field coexisting with a low density of energetic electrons is linearly and nonlinearly unstable if the distribution of energetic electrons is of the loss cone type, or is spherically symmetric in velocity space but nearly monoenergetic. Growth rates for linear and nonlinear instabilities are calculated and compared. It is shown that nonlinear growth rates may dominate for very low wave energy. (auth)

3393 STATIONARY EQUILIBRIUM FOR THE TOROIDAL THETA PINCH. Tasso, H.; Green, B. J.; Zehrfeld, H. P. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Fluids, 12: 2444-5(Nov. 1969).

It is already known that static (velocity V = 0), axisymmetric, toroidal equilibria with a purely toroidal magnetic field (toroidal theta-pinch configuration), do not exist. Here, this result is generalized to the case where the effects of inertia are included. (auth)

3394 EFFECT OF EMBEDDING CURRENT-CARRYING RINGS IN A STELLARATOR. Wiley, Davis S. (Princeton Univ., N. J.). Phys. Fluids, 12: 2434-6(Nov. 1969).

Insertion of current-carrying loops, perpendicular to the field and inside the plasma region, can localize the ballooning mode in a stellarator. Estimates of the efficiency of such rings indicate that present instability concepts can be tested on existing stellarators. (auth)

3395 CURRENT-CONVECTIVE INSTABILITY OF A WEAKLY IONIZED PLASMA IN THE PRESSURE OF A FEED-

BACK. Arsenin, V. V.; Chuyanov, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 315-17(Sept. 1969).

Translated from Zh. Tekh. Fiz., 39: 429-32(Mar. 1969).

The oscillations of a cylindrical current-carrying weakly ionized plasma column surrounded by a surface, on which an electronic feedback circuit excites a traveling electrostatic wave, were investigated. The wave is assumed to have a phase velocity equal to that of the electrostatic perturbation at the plasma boundary and amplitude proportional to that of the perturbation; the ion–neutral collision frequency is assumed to be much greater than the ion-cyclotron frequency and the electrons are assumed to be "magnetized." The oscillation spectrum of the plasma feedback system can differ substantially from that of a free plasma column. In particular, by suitable choice of the parameters of the feedback circuit it is possible to attenuate certain modes of the convective instability in the positive column; in the absence of feedback these are unstable when the magnetic field exceeds some critical value. This stabilization method is illustrated, and the results are applied to the first azimuthal mode. (auth)

3396 TRANSVERSE INSTABILITIES IN A COLLISIONLESS PLASMA. Smith, A. (Manchester Univ., Eng.). J. Plasma Phys., 3: 281-93(May 1969).

Transverse instabilities in an electron gas with a neutralizing background, in the absence of a permanent magnetic field are discussed, mostly when the equilibrium velocity distribution is slightly spheroidal. It is found that two types of unstable waves exist. It is shown that the complex phase velocity is pure imaginary, i.e., the unstable waves are standing waves. The effect of a small permanent magnetic field is considered. The maximum instability rate is compared with the collision rate and is found to be higher in low-density, high-temperature plasmas such as the solar wind. An application to collisionless shock theory is suggested. (auth) (UK)

3397 EFFECT OF FINITE LARMOR RADIUS ON RAYLEIGH–TAYLOR INSTABILITY OF A PLASMA. Ariel, P. D. (Malaviya Regional Engineering Coll., Jaipur, India); Bhatia, P. K. Can. J. Phys., 47: 2435-7(Nov. 15, 1969).

The effects of a finite Larmor radius of the ions are investigated on the Rayleigh–Taylor instability of a plasma in which there is a density gradient in a direction perpendicular to that of the magnetic field. It is found that the unstable configuration is completely stabilized by the finite Larmor radius effect. (auth) (Canada)

3398 DIOCOTRON INSTABILITY IN PRESENCE OF A COLD PLASMA. Nocentini, Aldo (Univ., Trieste, Italy). J. Plasma Phys., 3: 149-53(May 1969).

The influence of the presence of a low-density, cold plasma on the stability against electrostatic perturbations of a cylindrical layer of charged particles moving in a uniform magnetic field is considered. It is shown that the influence of the plasma is important when the thickness of the layer is small, and the effect is stabilizing or destabilizing whether the dielectric constant of the plasma is smaller or larger than 1. In particular it is shown that the plasma can cause an unstable precession of the layer. (auth) (UK)

3399 KINETIC THEORY OF THE STABILITY OF COLLISIONAL PLASMA IN CURVED MAGNETIC FIELD. Jungwirth, K. (Inst. for Plasma Physics, Prague). J. Plasma Phys., 3: 155-60 (May 1969).

The effect of curvature of magnetic field lines on plasma instabilities due to a large gradient of the ion temperature has been studied. It is shown that none of the discussed effects can be obtained so long as the curvature of magnetic field lines is simulated by a fictional gravitation field. In configurations with large enough minimum-B, the usual temperature-gradient instability is stabilized in collisionless plasma. However, a new dissipative instability arises due to ion–ion collisions. (auth) (UK)

3400 TURBULENT RELAXATION OF A PLASMA FAR FROM THE STABILITY THRESHOLD. Galeev, A. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zk. Eksp. Teor. Fiz., 57: 1361-75(Oct. 1969). (In Russian).

An anisotropic plasma far from the stability threshold is considered, when the appearance of collective oscillations affects the motion of the plasma particles. It is shown that the movement of particles in turbulent electric fields can be represented as the result of nonlinear phase shifts in the "wave + particle" system. This nonlinear effect does not prevent instability but merely decreases its increment. Instability in the nonlinear stage of its development can therefore be regarded as weak, and hence relaxation of the anisotropic ion distribution is studied on the basis of the quasi-linear theory developed for the given case. It is shown that instability disappears before relaxation to a completely stable state occurs. This is because instability is of the nature of consecutive oscillation spikes, each of which contribute to relaxation of the plasma. (auth)

3401 STABILITY OF INHOMOGENEOUS RELATIVISTIC ELECTRON BEAMS. Bogdankevich, L. S. (Lebedev Inst. of Physics, Moscow); Rukhadze, A. A.; Zhelyazkov, I. I. Nucl. Fusion, 9: 239-42(Oct. 1969).

The stability of a space-bounded relativistic beam of electrons accelerated by a nonuniform electric field was investigated under conditions where the transverse dimension of the beam is significantly greater than the Debye radius and a collective approach is necessary for describing small oscillations. For currents exceeding some critical value, there may develop in such a system an instability analogous to the "slipping" instability of nonrelativistic electron beams with a non-uniform velocity profile. The instability conditions are established and the instability growth rates calculated both in the absence and in the presence of a strong longitudinal magnetic field. The energy spread of the electrons has a stabilizing effect on the beam instability in question. It is shown that the slipping instability is characteristic of any nonuniform plasma flow. In particular, it may develop in an isotropic plasma if the flow velocities exceed the thermal velocity of the ions. (auth)

3402 SATURATION OF NONLINEAR EXPLOSIVE INSTABILITIES. Dum, C. T.; Sudan, R. N. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 23: 1149-51(Nov. 17, 1969).

The saturation of linear or nonlinearly (explosively) unstable high-frequency, electrostatic flute modes in a mirror-confined plasma is discussed. The mechanism proposed is the perturbation of particle orbits by the wave electric fields. (auth)

3403 ONE-, TWO-, AND THREE-DIMENSIONAL NUMERICAL SIMULATION OF TWO-BEAM PLASMAS. Morse, R. L.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett. 23: 1087-90(Nov. 10, 1969).

Comparable one-, two-, and three-dimensional simulations of electrostatic two-beam instabilities show major qualitative differences between one and two dimensions, and only small quantitative differences between two and three dimensions. In particular, the well-known persistence of vortex structure is lost in going from one dimension to two and three dimensions. (auth)

Thermonuclear Processes

3404 (AEC-tr-7059) LONG-WAVE PERTURBATIONS OF STELLARATOR MAGNETIC SYSTEM GEOMETRY. Danilkin, I. I. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17779. 40p. Dep. CFSTI.

An abstract of this paper, prepared from the original Russian report, appeared in NSA 23: 16768. (M.O.W.)

3405 (NP-tr-1856) BREAKUP OF MAGNETIC SURFACE IN THE S-1 STELLARATOR. Karmanov, F. V.; Cheremnykh, P. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Culham Lab., Abingdon, Eng., from report IAE-1260. 4p. (CTO-626). Dep. CFSTI (U. S. Sales Only).

While investigating the magnetic field in the S-1 stellarator, considerable deformations of the magnetic surfaces were observed. The deformations take the form of projections reaching out from the separatrix toward the chamber wall. They increase with an increasing h_3/H_0 ratio. (auth)

3406 (WASH-1132) FUSION TORCH: CLOSING THE CYCLE FROM USE TO REUSE. Eastlund, Bernard J.; Gough, William C. (Division of Research (AEC), Washington, D. C.). May 15, 1969. 25p. Dep. GPO $0.35.

Two concepts for the application of the ultrahigh-temperature plasmas now available in fusion experiments and eventually in controlled fusion reactors are discussed. The first concept is the use of ultrahigh-temperature plasma, in the form of a fusion torch, to reduce any material to its basic elements for separation. The second concept is the use of the fusion torch to transform the energy in the ultrahigh-temperature plasma into a radiation field, to permit process heating to be done in the body of a fluid. (M.O.W.)

3407 EROSION ELECTRODYNAMIC PLASMA ACCELERATOR WITH INDUCTIVE ENERGY STORAGE. Gurov, V. M.; Khizhnyak, N. A. (Inst. of Aviation, Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 338-42(Sept. 1969).

Translated from Zh. Tekh. Fiz., 39: 458-64(Mar. 1969).

A theoretical study of erosion electrodynamic plasma accelerators with inductive energy storage is presented. The results are compared with the data of other papers in which a similar investigation was carried out for capacitative energy storage. It is shown that for the same initial stored energy and same circuit discharge time, for inductive storage $1/\alpha = T/2\pi$ (where T is the current discharge time in the circuit with a capacitor) the parameters char-

acterizing the erosion of the plasma source with an inductive storage are practically the same as for a system with condensers. In the expression for the efficiency of energy transfer, the Meshcherskii term describing the energy consumed by the preacceleration of the eroded mass is introduced. It is shown that plasma acceleration in systems with inductive storage requires a longer time interval than in systems with condensers. (auth)

3408 SOME EFFECTS OF α PARTICLES IN A LOW-β FUSION REACTOR. Linhart, J. G. (EURATOM–CNEN, Rome). Nucl. Fusion, 9: 269-72(Oct. 1969).

It is shown that as soon as the plasma (D–T at approximately 2×10^8°K) begins to generate fusion energy, the departure from local thermodynamic equilibrium increases significantly, owing to trapped alpha particles. These particles create a substantial anisotropy in the velocity distribution. (M.O.W.)

3409 YIN–YANG MINIMUM-|B| MAGNETIC-FIELD COIL. Moir, R. W.; Post, R. F. (Univ. of California, Livermore). Nucl. Fusion, 9: 253-8(Oct. 1969).

A new conductor shape called a "Yin-Yang" coil is described. This coil produces a quadrupole magnetic well field, similar to the field of a Baseball-Seam coil, but with several important advantages. The Yin–Yang coil can produce a field of high mirror ratio (6, for example) with much less power than an equivalent Baseball-Seam coil. The Yin–Yang coil employs simple conductor shapes and has the flexibility inherent in two separate conductors. This permits the mirror ratio to be varied by changing the distance between the two conductors and to trap a plasma by energizing the coil segments sequentially. (auth)

3410 INDUCTIVE LENSES FOR IMPROVED MAGNETIC FIELD SYMMETRY IN A CORRUGATED THETA-PINCH COIL. Hartz, F.; Junker, J.; Pohl, F.; Wolf, G. H. (Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion, 9: 233-8(Oct. 1969).

The magnetic field distribution of corrugated theta-pinch coils is measured in an analog experiment (experimental error 0.05%) in order to determine the perturbation of the rotational symmetry induced by the current feed slot. The maximum deviations from rotational symmetry are found near the coil surface around the current feed slot. They have a value of a few per cent and are proportional to the width of the current feed slot. The perturbations decrease towards the coil axis to a few tenths per cent only. The distribution of a locally varying inductance of the current transmission line is computed and applied by moulding inductive lenses into the transmission line plates. The influence of the inductive lenses is measured. Within a radial region of about $\frac{1}{2}$ of the coil radius, the perturbations are found to be reduced to the level of the experimental error. The residual perturbations outside this region are mainly attributed to the limited space available for the application of the inductive lenses in the transmission line system. (auth)

3411 THERMONUCLEAR FUTURE OF THE "TOKAMAK" MAGNETIC CONFINEMENT DEVICE. Hubert, P. (EURATOM–CEA, Fontenay-aux-Roses, France). Nucl. Fusion, 9: 209-14 (Oct. 1969). (In French).

A possible extrapolation of the Tokamak principle towards a thermonuclear reactor raises many problems among which stress is laid on the minimum values required for the equilibrium and stability parameters. Some technological requirements are confronted with the most recent theoretical developments, revealing the existence of a small domain inside of which both points of view may be, perhaps, simultaneously satisfied. The operation of the reactor would have to be discontinuous but each cycle might conceivably include a plateau lasting about 10^3 sec. A major difficulty arises from the necessity to develop a heating method with an efficiency amounting to at least a few 10^{-3}, keeping in mind other requirements about the uneasy reactor technology. (auth)

3412 ENGINEERING FEASIBILITY OF CONTROLLED FUSION. A REVIEW. Rose, D. J. (Massachusetts Inst. of Tech., Cambridge. Oak Ridge National Lab., Tenn.). Nucl. Fusion, 9: 183-203(Oct. 1969).

The approximate parameters of steady-state D–T fusion reactors can be predicted on the basis of present knowledge, provided some interim assumptions are made. The most speculative assumption is plasma confinement: either about 100 Bohm times in a closed magnetic system whose minor plasma radius is several meters; or about 10 effective 90° Coulomb scattering times in an open system of similar size. Almost as serious is the assumption that a flux 3×10^{18} m^{-2} sec^{-1} of 14-MeV neutron will not cause excessive radiation damage to the device. A simple plasma model includes particle injection with or without energy, particle loss, electron bremsstrahlung and synchrotron radiation, thermalization of alpha particles (from fusion) and energy exchange between all species. It predicts equilibrium temperatures T, pressures, fractional burnup per confinement time f_b and other quantities. For open-ended systems f_b approaching 0.1 is required, which is several times that obtainable against simple Coulomb scattering; some possibilities for ameliorating this difficulty remain unexplored. Typically $T_i \approx 60$ to 80 keV, but $T_e \approx 30$ to 40 keV because of radiation. For closed systems f_b can be lower, but $f_b \approx 10\%$ with artificially enhanced bremsstrahlung would be more desirable. In every case, alphas are thermalized in the plasma. Using niobium structural material and mostly lithium moderator, one can obtain a (regenerated triton/incident neutron) breeding ratio between 1.2 and 1.6, depending upon the configuration. Cost per unit power would be very low for large systems. One intermediate example gives \$6/kW(th); $\beta = 0.15$ (closed system), 0.34 (open system), for a device with 3-m radius and 10 T maximum field. Total power could exceed 10,000 MW(th). The large neutron excess in such devices would be very valuable and there are other advantages. 46 references. (auth)

Wave Phenomena

Refer also to abstracts 3132 and 3373.

3413 (AEC-tr-7073) ANOMALOUS ABSORPTION OF CYCLOTRON WAVES IN CONFINED PLASMA. Bogdankevich, L. S.; Rukhadze, A. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Russian preprint No. 72. 20p. Dep. CFSTI.

The absorption of the cyclotron electron waves in a confined and rarefied plasma was investigated when the Larmor frequency of electrons exceeded considerably that of the plasma. Under such conditions the extraordinary cyclotron wave is absorbed rather strongly in a spatially unlimited plasma, while the ordinary wave is practically not absorbed at all. In a limited plasma (for example, a waveguide filled with plasma), due to the interaction of waves at the plasma boundary, absorption of the ordinary waves may become anomalously high if the wave length is of the order of the plasma dimension. At this, the absorption factor becomes an oscillating function of the wave length and system dimensions. Cases of high-temperature plasma without collisions and of cold plasma with a great number of collisions were examined. Recent experiments on absorption of the cyclotron waves in a limited plasma are discussed on the basis of the newly developed theory. (auth)

3414 (INR–1099) NUMERICAL SOLUTION OF A NONLINEAR PARABOLIC EQUATION. Bednarz, R. J.; Makosa, D. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 20p. Dep. CFSTI (U. S. Sales Only).

A difference scheme is developed for the solution of a nonlinear parabolic equation. The truncation error for the difference approximation to the equation and boundary conditions is of the second order. An initial-boundary-value problem related to quasi-linear theory of plasma oscillations is solved, using a program applying the scheme. (auth)

3415 (N–69-33202) PARAMETRIC MODE–MODE COUPLING BETWEEN DRIFT WAVES IN PLASMAS. Hai, Francis; Wong, Alfred Y. (California Univ., Los Angeles. Plasma Physics Group). Jan. 1969. 67p. (NASA-CR–103792; R–40). CFSTI.

The nonlinear phenomenon of parametric excitation of stable resonant drift modes through mode–mode coupling is examined in the potassium plasma of a Q device. The scheme investigated extensively is the degenerate case of three-mode parametric coupling in which the stable resonant mode (m = 1) at ω_1 is excited by the externally driven pump mode (m = 2) at $\omega_0 = 2\omega_1$. The usual frequency and wave number matching conditions are satisfied. The additional, new aspects examined are the enhancement of thermal fluctuations, the threshold for excitation, and the power balance between the coupled modes and the external source. The main results obtained are the measurement of the coupling coefficient and the determination of the functional behavior of the modes. To describe the steady-state amplitudes observed experimentally, nonlinear saturation phenomena are included. Nondegenerate and higher-order coupling schemes are briefly considered. Parametric coupling as a mechanism limiting the amplitude of an unstable mode and leading to a turbulent plasma is presented and discussed. (auth) (STAR)

3416 (SC–R–69-1368) REFLECTION AND TRANSMISSION CHARACTERISTICS OF A PLASMA SLAB HAVING ARBITRARY ELECTRON DENSITY AND COLLISION FREQUENCY PROFILES USING THE METHOD OF INVARIANT IMBEDDING. Harrison, Charles W. Jr. (Sandia Labs., Albuquerque, N. Mex.). Apr. 24, 1969. 19p. Dep. CFSTI.

It is shown that the transmission characteristics of the slab depend in a fundamental way on the reflection coefficient of the same

model. The reflection coefficient satisfies the Riccati differential equation. Once the reflection coefficient is known for bounded media with or without internal discontinuities, transmission through the plasma may be obtained in a variety of ways. It is shown analytically that the general equations yield correct results when applied to the homogeneous plasma slab model. The differential equations obtained in this study may be integrated without difficulty to any desired degree of accuracy, using a computer. (auth)

3417 (SC-R-69-1369) INTEGRAL FOR OBTAINING EXACTLY THE ELECTROMAGNETIC FIELD TRANSMITTED THROUGH A PLASMA SLAB HAVING SPECIFIED ELECTRON DENSITY-COLLISION FREQUENCY PROFILES. Harrison, Charles W. Jr. (Sandia Labs., Albuquerque, N. Mex.); Chang, David C. (Colorado Univ., Boulder). June 17, 1969. 8p. Dep. CFSTI.

The reflection coefficient of a nonhomogeneous plasma slab satisfies the Riccati differential equation. When the differential equation for the transmission coefficient is combined with the Riccati equation, the resulting expression is analytically integrable. It is demonstrated that transmission of an electromagnetic field through the slab may be expressed entirely in terms of an integral involving the complex wave number and reflection coefficient of the medium. It is shown that the exact theory presented here yields correct results when used to obtain the transfer function for a homogeneous imperfectly conducting sheet. (auth)

3418 (SU-IPR-336) STUDIES OF PLASMA OSCILLATIONS. Status Report No. 34, February 1–July 31, 1969. (Stanford Univ., Calif. Inst. for Plasma Research). Aug. 1969. Contract AT(04-3)-326. 57p. Dep. CFSTI.

Current activities include the following topics: (a) Low-frequency ion–acoustic and drift waves on the positive column in a magnetic field. An rf perturbation theory based on a self-consistent solution for the steady-state column has been derived, and is being tested experimentally. (b) Electron cyclotron echoes. Response of a magnetoplasma to short pulses at the cyclotron frequency is being studied. The detailed physical description of the phenomena involved permits the development of techniques for plasma density measurement and determination of collision data. (c) Beam/plasma interaction. Aspects of this phenomenon currently being studied are the effects on the interaction of inhomogeneity, beam and plasma temperature, and bounded beam and plasma geometry. (d) Wave/wave interactions. Basic equations of small-signal plasma wave theory may now be considered to have been well verified experimentally, and higher-order approximations can be attempted. Our work in this direction concerns the nonlinear coupling of cyclotron harmonic waves, Langmuir waves, and whistlers. (auth)

3419 ENHANCED SCATTERING AND ANOMALOUS ABSORPTION OF LIGHT DUE TO DECAY INTO PLASMA WAVES. Bornatici, M.; Cavaliere, A.; Engelmann, F. (EURATOM-CNEN, Frascati, Italy). Phys. Fluids, 12: 2362-73(Nov. 1969).

An intense collimated light beam of frequency ω_t incident on a quiescent plasma with plasma frequency $\omega_{pe} \ll \omega_t$ can couple with electron plasma waves, to enhance their level well above the equilibrium value. As a consequence, the spectrum of the scattered light "reddens," and a part of the beam energy is transferred to the plasma. For a bandwidth $\Delta\omega < \omega_{pe}$ of the beam, two basic regimes are important: one where the enhanced fluctuations travel at large angles to the light beam and which is the equivalent at high intensities of the equilibrium collective scattering, and a second, where electromagnetic and plasma waves have phase velocity nearly parallel and of the same order which seems suited for an important absorption of the light. Competing processes such as instability of the scattered light, and decay of plasma waves into ion–acoustic waves, become important in certain ranges of the beam and plasma parameters. All the mentioned processes are investigated in detail in the framework of lowest-order mode coupling using a corrected radom-phase approximation. The results indicate that nonlinearly enhanced scattering should be detectable for a beam of laser light passing through a laser-produced plasma, whereas it seems doubtful that the considered mechanism can produce an appreciable anomalous absorption. (auth)

3420 BOUNDED, RESONANTLY SUSTAINED HIGH-FREQUENCY PLASMAS IN A MAGNETIC FIELD AND DENSITIES HIGH ABOVE CRITICAL DENSITY. Messiaen, A. M.; Vandenplas, P. E. (Ecole Royale Militaire, Brussels). Phys. Fluids, 12: 2406-17(Nov. 1969).

It is shown that the wave properties of a magnetized plasma column, i.e., of a bounded magnetized plasma, at low incident high-frequency power determine the behavior of the column at high hf power. At high hf power, the energy absorbed is sufficient to sustain the plasma in one of its linear (i.e., low-power) resonant states. The plasma can either be sustained in one of its cold plasma resonant states or in its hot plasma resonant states. A partially quantitative theoretical picture can be drawn and maxima of the density as a function of B_0 (static magnetic induction) exactly predicted. In this manner densities high above critical density ($\omega_e > \omega$; ω is the angular frequency of hf field; ω_e is the electron plasma frequency) can be obtained in the neighborhood of the lower cyclotron harmonics and along the upper branch of the cold plasma resonances. Ejection of plasma outside the interaction region between plasma and wave is observed. This ejection gives rise to plasma "tongues" with density maxima not correlated to the density of plasma in the interaction region. Low-frequency instabilities and the generation of harmonics are also investigated. (auth)

3421 NONLINEAR DEVELOPMENT OF AN ELECTRON PLASMA WAVE IN A CYLINDRICAL WAVEGUIDE. Manheimer, Wallace M. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 12: 2426-2426-8(Nov. 1969).

It is shown that in a cylindrical waveguide, a long-wavelength electron plasma wave steepens exactly as does a nonlinear sound wave. Possible applications to experiments are discussed. (auth)

3422 EFFECT OF ELECTROSTATIC FIELD ON PROPAGATION OF ELECTROMAGNETIC WAVES IN AN ANISOTROPIC PLASMA. Bachynski, M. P.; Gibbs, B. W. (RCA Ltd., Montreal). Phys. Fluids, 12: 2447-9(Nov. 1969).

A laboratory experiment was conducted to test the theory of Hsieh relating to the effect of an electrostatic field on propagation of electromagnetic waves in an anisotropic plasma. Experiment does not support this theory. (auth)

3423 ELECTROACOUSTIC RESONANCE DENSITIES IN AFTERGLOW PLASMAS. Lustig, C. D. (Sperry Rand Research Center, Sudbury, Mass.). Phys. Fluids, 12: 2454-5(Nov. 1969).

The electron densities at which electroacoustic (Tonks–Dattner) resonances were excited in an afterglow plasma column were measured with a microwave cavity and compared with theoretical predictions. (auth)

3424 NONLINEAR THEORY OF ION ACOUSTIC WAVES WITH LANDAU DAMPING. Ott, E.; Sudan, R. N. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 12: 2388-94(Nov. 1969).

The following macroscopic equation is shown to govern the time development of a nonlinear ion–acoustic wave:

$$\frac{\partial n}{\partial \tau} + \alpha_2 n \frac{\partial n}{\partial \xi} + \alpha_3 \frac{\partial^3 n}{\partial \xi^3} + \frac{\alpha_4}{(8\pi)^{1/2}} P \int_{-\infty}^{+\infty} \frac{\partial n}{\partial \xi'} \frac{d\xi'}{\xi - \xi'} = 0,$$

where n, ξ, and τ are normalized wave amplitude, space, and time coordinates, and α_1, α_2, α_3 are parameters which depend on the relative strengths of Landau damping, nonlinearity, and dispersion. The first three terms constitute the Korteweg–de Vries equation, and the last term represents the effect of Landau damping. The equation conserves the number of particles but the wave energy can be shown to decay always. It is demonstrated that an initial waveform may either steepen or not depending on the relative size of the nonlinearity as compared to Landau damping. It is also shown that the Landau damping term causes the amplitude of a solitary wave to decay with time as $(\tau + \tau_0)^{-2}$. (auth)

3425 EFFECT OF ELECTRON TRAPPING ON THE ION-WAVE INSTABILITY. Nishikawa, K.; Wu, Ching-sheng (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 23: 1020-2 (Nov. 3, 1969).

It is found that, in many cases, electron trapping can have an important effect on ion waves. Trapping can render the linear stability theory invalid, and the conditions under which this may occur are discussed. Assuming the trapping process to be the mechanism whereby an unstable plasma reaches a quasi-stationary turbulent state, an expression is derived for the saturation energy spectrum. (auth)

3426 NONLINEAR COUPLING OF WAVES IN A MAGNETIZED PLASMA WITH PARTICLE DRIFT MOTIONS. Wilhelmsson, H. (EURATOM–CNEN, Rome). J. Plasma Phys., 3: 215-26(May 1969).

Nonlinear interaction between three monochromatic waves that propagate parallel to the direction of a magnetic field in a plasma is studied. The approach to the problem is hydromagnetic, including temperature effects, and the method of solution is that of coupled-mode theory. In particular, drift motions of the particles along the magnetic field are considered, taking into account relativistic effects. The interaction of two transverse waves and one longitudinal wave is treated, as well as that of three longitudinal waves. Also, the case of two longitudinal waves and one perpendicular wave is studied in some detail, assuming the latter to have a long wavelength. A generalization of the problem of three-wave

interaction in a plasma to situations more complex than have been treated before is presented. The most essential limitation lies in the assumptions made for the directions of propagation of the waves. (auth) (UK)

3427 GROWTH AND DECAY OF RESONANT PLASMA OSCILLATIONS EXCITED BY A SMALL PULSED DIPOLE. Fejer, J. A.; Yu, Wai-mao. (Univ. of California, La Jolla). J. Plasma Phys., 3: 227-41(May 1969).

The application of integration by the method of stationary phase to resonant oscillations excited by a small pulsed dipole is outlined. Both the growth and the decay of the oscillations near the plasma frequency are determined by this method at a fixed distance from the dipole, first in the absence and then in the presence of an external magnetic field. It is shown that Landau damping must be taken into account in the calculation of the growth but not of the decay. The oscillations are shown to spread out with a speed that is half the mean thermal speed of electrons. Only the decay, not the growth, of the oscillations near harmonics of the cyclotron frequency can be calculated by the same method. It is shown, moreover, that the amplitude, calculated for an observation point that moves away with satellite velocity in an ionospheric environment, is only valid for time delays longer than about a minute. Such a result is therefore of no practical interest because the resonances observed from satellites only last a few milliseconds. The erroneous nature of using such a result and the need for a different approach, such as that used in earlier work by the first author, are thus demonstrated. (auth) (UK)

3428 QUANTITATIVE QUASI-LINEAR ANALYSIS OF WAVES IN AN ANISOTROPIC PLASMA. Smith, A. (Univ. of the West Indies, Jamaica). J. Plasma Phys., 3: 295-309(May 1969).

The quasi-linear theory of plasma waves in a collisionless plasma in the absence of external fields is formulated in a similar way to that given by Bernstein and Engelmann (1966) but is applied to the case when unstable essentially transverse electromagnetic waves with phase velocities of the order of the r.m.s. electron velocity are present. It is deduced that the wave energy reaches a maximum and then decays leaving the plasma stable. A quantitative description of the time development of a plasma with a slightly spheroidal velocity distribution is given. (auth) (UK)

3429 ELECTROMAGNETIC PULSE SCATTERING IN TIME-VARYING INHOMOGENEOUS MEDIA. Taylor, Clayborne D.; Lam, Dong-hoa; Shumpert, Thomas H. (Mississippi State Univ., State College). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 585-9(Sept. 1969).

A finite difference solution technique is used to solve Maxwell's equations directly in the treatment of electromagnetic pulse scattering in a time-varying inhomogeneous medium. In particular the scattering from a cylindrical rod inside a cylindrical waveguide is considered where axial symmetry is obtained. (auth)

3430 TRANSIENT WAVES IN ANISOTROPIC PLASMAS. Case, Carl T.; Haskell, Richard E. (Air Force Cambridge Research Labs., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 674-5(Sept. 1969).

The experimentally significant, long-time transient response of a lossless anisotropic plasma to a short electromagnetic pulse is given. Natural oscillations asymptotically approach the plasma cutoff and resonance frequencies. In addition, complicated transient polarization effects are present in the response signal. (auth)

3431 STUDY OF THE PHASE SHIFT EXISTING AMONG OSCILLATIONS OF DENSITY AND LOCAL POTENTIAL IN A CESIUM PLASMA. Cussenot, Jean-Rene; Haug, Robert (Laboratoire de Physique des Millieux Ionises, Nancy). Compt. Rend., Ser. B, 269: 253-5(Aug. 4, 1969). (In French).

A method of measuring the relative phase shift between oscillations of density and local potential is explained, then tested in a cesium plasma which is perturbed by making the potential of a large-dimension grid vary sinusoidally. (tr-auth)

3432 ON THE SPECTRA OF LANGMUIR PLASMA TURBULENCE. Liperovskii, V. A.; Tsytovich, V. N. (Inst. of Cosmic Studies, Moscow). Zk. Eksp. Teor. Fiz., 57: 1252-62(Oct. 1969). (In Russian).

The nonlinear equations for the interaction between Langmuir waves in a plasma are employed for determining the total shape of the quasi-stationary turbulence spectrum W_k. It is assumed that the stationary source produces turbulent energy in the region of very large k and the energy is subsequently transmitted to the region of the fundamental turbulence scale $L = 2\pi/k_0$, where it is damped. The turbulence spectrum in the region of large values of k is calculated for various values of the plasma temperature and turbulence production power Q. An approximate analytic dependence of the fundamental turbulence scale on Q is found: $L = \text{const} \cdot Q^{1/(\nu-1)}$, where ν is the exponent in the turbulence spectrum $W_k \sim k^{-\nu}$ in the small k range. The effect of fast particles accelerated by turbulence on the spectrum of the latter is investigated. Self-consistent distributions of fast particles and turbulent pulsations are found. For a sufficiently high level of plasma turbulence, the fast-particle spectrum should have the shape $f(\epsilon) \sim \sqrt{\epsilon}$. The condition for disappearance of the maximum in the turbulence spectrum due to absorption by fast particles is found. (auth)

3433 NONLINEAR WAVES KINETICS IN DISPERSIVE MEDIA. Zaslavskii, G. M.; Filonenko, N. N. (Novosibirsk State Univ., USSR). Zk. Eksp. Teor. Fiz., 57: 1240-51(Oct. 1969). (In Russian).

Solutions of the Korteweg-de Vries equation in the form of periodic wave trains with very large wavelengths are considered. It is shown that under certain conditions superposition of such nonlinear waves may be regarded as the zero approximation of the solution. Corrections to the solution are found by perturbation theory, the perturbation being resonant nonlinear wave interaction. It is shown that if the number of nonlinear waves are large the wave phases become random functions of time. A kinetic equation describing a nonlinear wave ensemble is derived and some of its particular solutions are found. A power dependence of the mean wave energy on wavelength is obtained, which corresponds to the Kolmogorov turbulence theory. (auth)

3434 LINEAR TRANSFORMATION OF WAVES IN A NONUNIFORM MAGNETO-ACTIVE PLASMA. Piliya, A. D.; Fedorov, V. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zk. Eksp. Teor. Fiz., 57: 1198-1209(Oct. 1969). (In Russian).

Solutions of the wave equation for a nonuniform magneto-active plasma are considered. Allowance is made for weak spatial dispension in the presence of a point in the plasma at which the zero component of the dielectric permeability tensor ϵ_{xx} vanishes (x is a coordinate on which the particle concentration depends; the magnetic field may form an arbitrary angle with the x axis). It is shown that for $|\epsilon_{xx}| \ll 1$ the solution of the equation can be described by a standard function, its asymptotic form at a distance from the point $\epsilon_{xx} = 0$ being a superposition of plasma waves and the equation solution without allowance for spatial dispersion. In general, the superposition coefficients are different in various parts of the x complex plane. However, if the incident plasma wave is absent in a certain sector of the plane which includes the lower semiplane and the real x axis, the equation solution for a cold plasma enters the superposition with a constant coefficient. It is shown that, in the lower order with respect to the parameter which takes dispersion into account, the amount of energy removed by the plasma wave is the same as the amount of energy absorbed in the cold plasma. For a strongly nonuniform plasma, solutions are obtained in the cases when the equations do not break up into independent second-order equations. These solutions are used for determining the conditions at the plasma–vacuum boundary. The presence of a transition region in which the concentration gradually drops to zero is taken into account. (auth)

3435 INFLUENCE OF DISSIPATIVE EFFECTS ON ELECTRO-ACOUSTIC WAVES IN A PLASMA. Gurovich, V. Ts.; Karpman, V. I. Zk. Eksp. Teor. Fiz., 57: 1458-62(Oct. 1969). (In Russian).

Asymptotic formulas are obtained which describe the evolution of solitary electro-acoustic waves in a plasma due to the electron–ion collisions. (auth)

3436 COMPRESSIVITY TENSOR AND DISPERSION RELATION FOR A PLASMA. Chen, Hollis C. (Ohio Univ., Athens). Amer. J. Phys., 37: 1022-9(Oct. 1969).

By the introduction of the compressivity and the permittivity tensors, the governing equations for a lossy, compressible, and anisotropic electron plasma are reformulated. The compressivity tensor takes into account the thermal motions of the electrons, while the permittivity tensor characterizes the anisotropy of the medium due to an external static magnetic field. A general dispersion relation with the coefficients in terms of the components of the compressivity and the permittivity tensors is obtained. The nature of the small oscillations in the plasma is thus determined completely by the two tensors. In the general case, the dispersion relation cannot be factorized into products which show the coupling between electromagnetic and plasma waves. Various simplifying assumptions which give some insight into the complex structure of the dispersion relation are examined. Some numerical results are also included. (auth)

3437 NONLINEAR DECAY PROCESSES OF THREE ELECTROMAGNETIC WAVES IN A WARM MAGNETIZED PLASMA.

Cano, R.; Etievant, C.; Fidone, I.; Granata, G. (EURATOM–CEA, Fontenay-aux-Roses, France). Nucl. Fusion, 9: 223-31 (Oct. 1969).

The wave–wave coupling of two high-frequency electromagnetic waves launched into a warm plasma across the constant confining magnetic field is discussed, using the Maxwell–Vlasov equations for electrons. The generation of an ordinary wave by the interaction of an extraordinary and an ordinary wave and the generation of an extraordinary wave by the interaction of two ordinary ones are described. The decay conditions and the amplitudes of the secondary waves are discussed numerically for different values of the electron temperature. (auth)

3438 DISPERSION RELATIONS FOR ION CYCLOTRON OSCILLATIONS. Shoucri, M. M. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Nucl. Fusion, 9: 205-8(Oct. 1969).

The natural modes of oscillation of a cold plasma, in the presence of a longitudinal external magnetic field, are examined near the ion cyclotron frequency. It is shown that under appropriate conditions, both the ordinary and the extraordinary hydrodynamic waves can be modified, giving modes whose natural frequency is in the neighborhood of the ion cyclotron frequency. Dispersion relations for these modes are given in the case of cylindrical geometry, and the excitation of oscillations close to the ion gyrofrequency by a small-density beam is discussed. (auth)

3439 EXCITATION OF ION–CYCLOTRON OSCILLATIONS OF PLASMA. Kitsenko, A. B. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 1515-18(Sept. 1969). (In Russian).

The excitation of ion-cyclotron oscillations in a plasma penetrated by a helical beam was studied. Waves propagating across the external magnetic field were considered. The instability of longitudinal oscillations is shown to appear under the resonant conditions when the lower hybrid frequency is multiple of the ion gyrofrequency. The excitation of fast waves with frequencies close to harmonics of the ion gyrofrequency is possible. (auth)

Shielding

Refer also to abstracts 3491, 3492, 3800, 3803, and 3953.

3440 (N–69–35848) EVALUATION OF THE COHORT II MONTE CARLO SHIELDING CODE: GAMMA RAY TRANSPORT USING SOURCE DIRECTION BIASING. Bloomfield, Harvey S.; Clemons, Lester Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1969. 9p. (NASA-TM-X–1877). CFSTI.

An evaluation of the gamma-ray transport portion of the COHORT II Monte Carlo shielding code is presented. This evaluation was accomplished by solving the point source, infinite medium, scattering problem and comparing COHORT II output spectra with the widely accepted moments method solution of the same problem. In addition, the COHORT II source angular biasing option was shown to be a valid technique for reduction of variance. (auth) (STAR)

3441 (ORNL-TM–2757) OGRE CROSS SECTION PACKAGE FOR USING PHOTON INTERACTION DATA IN ENDF/B FORMAT. Trubey, D. K.; Stockton, J. R. (Oak Ridge National Lab., Tenn.). Oct. 27, 1969. Contract W-7405-eng-26. 11p. Dep. CFSTI.

A new version of the OGRE Monte Carlo computer code system for gamma-ray transport makes use of ENDF/B formatted photon interaction data. These data may be either BCD or binary and eliminates the use of the OGRE-format BCD and binary master tapes and the master tape handling program (MASTAP). (auth)

3442 NEUTRON STREAMING THROUGH DUCTS. Soong, Y. T. (Naval Civil Engineering Lab., Port Hueneme, Calif.); Huddleston, C. M.; Chilton, A. B. Nucl. Sci. Eng., 38: 182-7(Nov. 1969).

An analytical approach is used on the problem of neutrons penetrating a straight rectangular duct. Neutron current is taken as the dependent variable in the duct transport equation, and the solution is obtained by the method of successive substitutions. (D.L.C.)

Solid-State Physics

Refer also to abstracts 3915 and 3916.

Radiation Effects

Refer also to abstract 2266.

3443 (AD–691138) EFFECTS OF ^{60}Co GAMMA IRRADIATION ON YVO_4, YVO_4:Eu^{3+}, AND YVO_4:Nd^{3+}. Final Report. Smith, Bennett Michael (North Carolina State Univ., Raleigh). June 1969. Contract DAAH01-67-C-1456. 79. CFSTI.

The absorption and fluorescent spectra of single crystals of YVO_4, YVO_4 : Eu^{3+} are discussed and illustrated, and the effects of ^{60}Co gamma irradiation upon the spectra are presented. Irradiation produced similar changes in the absorption coefficient of these crystals. Small center bands were formed in the ultraviolet and visible regions. The intensity of the fluorescent emission from both YVO_4 and YVO_4 : Eu^{3+} was decreased by irradiation, while the emission intensity of YVO_4 : Nd^{3+} was not affected. Speculations about the nature of the mechanisms producing the irradiation effects are discussed. Gamma irradiation produces ionization in crystals, and some of the free electrons and holes created become trapped at lattice defects. The changes in emission and absorption in the YVO_4 crystals are interpreted as due to the trapped holes and electrons. (auth) (USGRDR)

3444 (CEA-R–3757) A STUDY BY INTERNAL FRICTION OF DEFECTS PRODUCED IN IRON AND NICKEL IRRADIATED AT VERY LOW TEMPERATURES. de Keating-Hart, Gauthier (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). July 1969. 86p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

After a brief review of the theory of internal friction, some technical innovations aimed at increasing the flexibility of the apparatus are discussed. These innovations extend the range of measurements down to 20°K. Preliminary experiments on electron-irradiated iron and the evidence for a laminar structure are discussed. The first measurements on nickel after neutron irradiation at 27°K are compared with those obtained by other methods. Transitory peaks at low temperature due to close Frenkel pairs were observed and the absence of a peak which would correspond to the magnetic after-effect band of stage I_E was noticed. An attempt is made to explain the disappearance of the observed peaks upon the application of an internal saturating magnetic field. (auth)

3445 (IEA–151) FRENAI: A PROGRAM FOR CALCULATION OF THE ENERGY LOSS SPECTRA FOR MONOENERGETIC GAMMA RAYS IN SODIUM IODIDE. Hehl, Wilma Sonia Caiaffa (Instituto de Energia Atomica, Sao Paulo (Brazil)). Oct. 1967. 18p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The calculations are performed using the Monte Carlo Method. The code is written in Fortran-II-D language and designed for use on the IBM-1620 mod. II of the Institute de Energia Atômica de São Paulo. (auth)

3446 (ISSP-A–382) EXCITATION-INDUCED INFRARED OPTICAL ABSORPTION IN SILVER AND ALKALI HALIDES. Kanzaki, Hiroshi; Hattori, Takeshi; Sakuragi, Shiro (Tokyo Univ. (Japan). Inst. for Solid State Physics). Sept. 1969. 26p. Dep. CFSTI (U. S. Sales Only).

Excitation-induced absorption spectra in silver and alkali halides are obtained as "excitation-spectra" of ir-enhanced fluorescence measured by illuminating with monochromatic ir light simultaneously with steady uv or x-ray irradiation. The unusually slow decay of the induced absorption can be correlated with the slow decay component of fluorescence in silver halides. Long-lived triplet states of bound excitons are proposed for the origin of the induced absorption. (auth)

3447 RADIATION DAMAGE IN RADIO-FREQUENCY-SPUTTERED SiO_2 FILMS. Hickmott, T. W. (IBM Components Div., Hopewell Junction, N. Y.). Appl. Phys. Lett. 15: 232-4 (Oct. 1, 1969).

The optical absorption and electron spin resonance of atomic defects in rf-sputtered SiO_2 films were measured. The properties of the centers are similar to those produced when pure, fused SiO_2 is bombarded with neutrons. (auth)

3448 LATTICE DISORDER PRODUCED IN Si BY 40-KeV BORON AND ITS EFFECT ON ELECTRICAL BEHAVIOR. Hart, R. R.; Marsh, O. J. (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Lett. 15: 206-8(Oct. 1, 1969).

The lattice disorder produced by 40-keV boron ions in Si at implant temperatures of −120 and 23°C was measured by means of the channeling technique for a 140-keV proton beam. At −120°, there are ~650 displaced Si atoms per incident boron ion for random and ⟨111⟩ aligned implants, respectively. In contrast to the mild dependence noted earlier for Sb implants, there is a marked dependence of residual lattice disorder upon implant temperature for boron implants in this temperature range. Hall effect measurements on the implanted layers indicate that, in the dose range for boron investigated, the electrical yield (number

of acceptors per implanted ion) after a 600°C anneal increases with the amount of disorder contained in the implanted layer, with the greatest yield occurring in implants containing a fully amorphous layer. The major effect of implant temperature is to determine the amount of residual disorder. (auth)

3449 OPTICAL AND ELECTRICAL PROPERTIES OF URANIUM-DOPED LiF AND KCl. Sootha, G. D.; Radhakrishna, S.; Agarwal, S. K. (Indian Inst. of Tech., New Delhi). Nuovo Cim., 64B: 19-27(Nov. 11, 1969).

LiF crystals containing uranium show two bands at 240 and 305 nm with half-widths 0.99 and 0.54 eV, respectively. Low temperatures (77°K) reduce the half-width of the 305-nm band to 0.94 eV and shifts it to 290 nm. No new bands are found at room temperature in KCl: U. At 77°K, uranium-doped KCl crystals show two bands at 234 and 270 nm. In LiF: U, on x-irradiation the band at 305 nm decreases. The growth rate of the F centers is found to be faster in uranium-doped LiF crystals. Two new bands, at 900 and 980 nm, are found in x-irradiated uranium-doped LiF crystals. These bands are found to be stable up to 150°C. The values of energies derived from the conductivity plot are W_i = 2.68 eV for the energy of formation of a separated pair of vacancies, E = 0.72 eV for the energy of activation for the migration of a cation vacancy, and W_a = 0.51 eV for the energy of association of a cation vacancy with a uranium center in LiF and 0.45 eV in KCl. Uncolored LiF: U and KCl: U give rise to a broad EPR line at room temperature. At low temperature (77°K), this narrows down to 150 G in KCl. On x irradiation, these signals are reduced in intensity. (auth)

3450 ELECTRON PARAMAGNETIC RESONANCE OF DEFECTS IN ION-IMPLANTED SILICON. Brower, K. L.; Vook, F. L.; Borders, J. A. (Sandia Labs., Albuquerque, N. M.). Appl. Phys. Lett., 15: 208-10(Oct. 1, 1969).

The first EPR measurements of the identity of defects in an ion-implanted layer (<15,000 Å) are reported. The Si-P3 center is the dominant paramagnetic defect produced at room temperature by 400-keV O^+ implantation in Al- and B-doped Lopex Si, and it anneals below 200°C. The Si P1 center is the dominant defect remaining above 200°C, and it anneals near 350°C. Interstitial Al^{2+} (Si-G18) are observed in the Al-doped sample; their number indicate that Si interstitials do not migrate over large distances into the unirradiated Si. Comparison of EPR and infrared data indicates that the Si divacancy is produced in the diamagnetic neutral charge state. (auth)

3451 MAGNETIC CIRCULAR DICHROISM OF THE F_3^+ CENTER IN NaF. Davis, J. A.; Fitchen, D. B. (Cornell Univ., Ithaca, N. Y.). Solid State Commun., 7: 1363-5(Sept. 15, 1969).

A temperature-independent magnetic circular dichroism proportional to the change in the first moment of the 5456-A absorption line has been measured for the F_3^+ center in NaF produced by prolonged x irradiation at room temperature. The results confirm that the transition is $^1A_1 \rightarrow {}^1E$ and indicate the presence of Jahn-Teller distortion in the excited state. (auth) (UK)

3452 ON THE THERMOLUMINESCENCE OF CRYSTALLINE GeO_2. Boehm, Horst (Eidgenoessische Technische Hochschule, Zurich). Solid State Commun., 7: 1511-18(Oct. 15, 1969).

Experiments of thermoluminescence and fluorescence were carried out on pure and doped GeO_2. The thermally stimulated conductivity was recorded simultaneously with the luminescence emission. The samples were cooled to -190°C and heated after x-ray irradiation. (auth) (UK)

3453 RADIATIVE SPUTTERING OF COPPER SINGLE AND POLYCRYSTALS IN THE RADIATION FIELD OF A NUCLEAR REACTOR. Garber, R. I.; Karasev, V. S.; Kolyada, V. M.; Fedorenko, A. I. (Inst. of Physics and Tech., Kiev). Zk. Eksp. Teor. Fiz., 57: 1081-5(Oct, 1969). (In Russian).

Sputtering of single-crystal and polycrystalline copper targets irradiated in a reactor with fast neutron fluxes of 2×10^{12} neutron $\cdot$ cm^{-2} sec^{-1} and doses up to 10^{19} neutron $\cdot$ cm^{-2} is studied. The angular distributions of ejected atoms from the single crystals indicate a predominant sputtering in directions of dense atomic packing in the crystals. The sputtering intensity I and energy of the electrified atoms E from the single crystals are, at the beginning of irradiation, twice as large as the same quantities for the polycrystals. With increase of dose, this difference decreases. The results are discussed by invoking collision-focusing mechanisms and channeling of the shifted atoms in the crystals. (auth)

3454 DAMAGE AND RECOVERY OF ALUMINUM FOR LOW-ENERGY ELECTRON IRRADIATIONS. Simpson, H. M.; Chaplin, R. L. (Clemson Univ., S. C.). Phys. Rev., 185: 958-61(Sept. 15, 1969).

Damage rates for samples of high-purity aluminum have been measured as a function of the electron irradiation energy from 0.16-0.40 MeV. A detailed analysis of the data is presented and the results indicate that the threshold energy for an atomic displacement in aluminum is 16 eV. Experimental values of the fractional amount of stage-I recovery show that the percentage of stage I is not a simple function of the irradiation energy. The observed energy dependence is explained in terms of the production of sub-threshold damage events. (auth)

3455 ON THE SURFACE POTENTIAL IN InSb WITH X-RAY IRRADIATION. Kreutz, E. W.; Pagnia, H.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Solid State Commun., 7: 1351-4(Sept. 15, 1969).

The role of surface potential v_{ss} on the electrical transport properties of InSb with x-irradiation measurements at T = 79°K is described. Magnitude and sign of the conductivity changes under irradiation depend only on the value of the surface potential. (auth) (UK)

3456 INDUCED ABSORPTION BAND IN THE N REGION OF LiF CRYSTALS BY CHARGED-PARTICLE IRRADIATION AT LIQUID NITROGEN TEMPERATURE. Kamikawa, Tomoyoshi; Ozawa, Kunio (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap., 27: 1212-16(Nov. 1969).

Single crystals of lithium fluoride have been irradiated with deuterons or protons at liquid nitrogen temperature (LNT). In absorption spectra of the crystals immediately after irradiation, a band is observed at 542 nm in addition to the F and M bands. This band has an almost constant intensity during warming from LNT to room temperature (RT). It is obscured by the other overlapping bands when the crystal is heated above 100°C or when this is aged at RT for a long time. The nature of this band is examined in connection with the so-called N_2 band, Farge's I band, and Vander Lugt's N_c band. The following relation is believed to be most plausible: The observed absorption band is identified with the I band. The N_2 band is identified with the N_c band but may not be identified with the I band. (auth)

3457 COLORATION OF LiF PRODUCED BY 3.0 MeV ^{40}Ar IONS. Van der Lugt, K. L.; Comas, J.; Wolicki, E. A. (Naval Research Lab., Washington, D. C.). J. Phys. Chem. Solids, 30: 2486-90(Oct 1969).

The F-center growth curve obtained from the 3.0-MeV ^{40}Ar ion bombardment is shown. It is linear up to approximately 2.8×10^{18} F centers/cc. From the slope of the linear portion of the growth curve, it is determined that 2600 F centers are created per incident ^{40}Ar ion, which yields an efficiency of 1150 eV per F center. Saturation of the F-center concentration in LiF due to the 3.0 MeV ^{40}Ar irradiation at room temperature occurs at approximately 4.25×10^{19}/cc. (auth) (UK)

Physical Properties

Refer also to abstracts 2357, 3019, 3021, 3824, 3831, and 3832.

3458 (JINR-P14-4548) NEUTRON-DIFFRACTION INVESTIGATION OF HEMATITE IN MAGNETIC FIELD TO 120 kOe ON PULSED FAST REACTOR. Antsupov, P. S.; Voskanyan, R. A.; Levitin, R. Z.; Nizel, S.; Nitts, V. V.; Ozerov, R. P.; Pak Kuan O., Shafran, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 22p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The technique of investigation of monocrystal magnetic structure in a strong pulsed magnetic field by neutron diffraction using the time-of-flight method is described. The effect of the field (to 120 kOe), which is parallel to the second-order axis, on the magnetic structure of the weak ferromagnetic, hematite (α-Fe_2O_3), below the Morin point is investigated. Anomalous increase of the neutron scattering on the plane (111) in the 48 kOe field was observed. The direction of the magnetic moments deflection from C_3 axis is determined as well as the sign of the constant of the anisotropy term. The experiments were performed on the pulsed fast reactor. (auth)

3459 (SC-RR-69-571) ELECTRONIC PROPERTIES OF RARE EARTH-HYDRIDES. Heckman, R. C. (Sandia Labs., Albuquerque, N. Mex.). Nov 1969. 35p. Dep. CFSTI.

The literature on the electrical conductivity, Hall effect, magnetic, nuclear magnetic resonance, and positron annihilation properties, and on the electronic heat capacities of the rare earth hydrides is reviewed. Discussion is focused on the implications of the results of electronic property measurements with regard to hydrogen to metal bonding and conduction band populations. It is concluded that hydrogen in these materials is largely protonic, the hydrogen electron being added to the material conduction band. At limiting compositions, such as $CeH_{3.0}$, the conduction band is approximately filled. (auth)

3460 PHYSICS OF SOLIDS IN INTENSE MAGNETIC FIELDS. Lectures Presented at the First Chania Conference Held at Chania, Crete, July 16–29, 1967. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969. 498p. (CONF-670735).

Most of the proceedings of the subject conference are collected in the twenty-five chapters of this book. Separate abstracts were prepared for four of the chapters. (L.M.T.)

For abstracts of individual chapters see: 3268–3270 and 3480.

3461 ELECTRONIC STRUCTURES IN SOLIDS. Lectures Presented at the Second Chania Conference, Held in Chania, Crete, June 30–July 14, 1968. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969. 472p. $25.00. (CONF-680663).

A total of 32 lectures are included on the following topics: tunneling, band structure, magneto-optics, semiconductors, x-ray scattering, impurities, excitons, nonradiative recombination, neutron scattering by fluctuations in condensed matter, phonons, superconductivity, quantum theory, Kondo effect, nonlinear optics, plasmons, Gunn effect, and energy conversion. Separate abstracts were prepared for 5 of the lectures. (D.L.C.)

For abstracts of individual papers see: 3221, 3271, 3272, 3275, and 3832.

3462 HYPERFINE INTERACTION IN Gd IN DIAMAGNETIC, METALLIC HOSTS. Frankel, R. B. (Technische Hochschule, Munich. Massachusetts Inst. Tech., Cambridge). Phys. Lett., 30A: 269-70(Nov. 3, 1969).

Moessbauer effect data for dilute, paramagnetic Gd in the diamagnetic, metallic hosts YAl_2, $YbAl_2$, and Al are analyzed and yield a local conduction electron polarization contribution to the Gd hyperfine field of +140 kOe. (auth)

3463 THERMIONIC EMISSION FROM (100) FACES OF SINGLE CRYSTALS OF TUNGSTEN, RHENIUM, TANTALUM, AND MOLYBDENUM ALLOYS. Smirnova, N. B.; Smirnov, B. G.; Mikhailov, S. M.; Sytaya, E. P. (Lenin State Univ., Tashkent). Sov. Phys.-Solid State (Engl. Transl.), 11: 784-6(Oct. 1969).

Translated from Fiz. Tverd. Tela, 11: 962-4(Apr. 1969).

The thermionic properties of the (100) faces of single crystals of the following alloys were investigated: W + 5% Re (WR-5), Mo + 27% Re (MR-27), Ta + 20% Mo (TM-20). The method of Richardson lines was used to determine the emission parameters: the work function φ and the constant A_{eff}. The following values were found: $\varphi = 4.52$ eV, $A_{eff} = 11\ A \cdot cm^{-2} \cdot deg^{-2}$ for the WR-5 alloy; $\varphi = 4.36$ eV, $A_{eff} = 150\ A \cdot cm^{-2} \cdot deg^{-2}$ for MR-27; $\varphi = 4.38$ eV, $A_{eff} = 43\ A \cdot cm^{-2} \cdot deg^{-2}$ for TM-20. (auth)

3464 EXCHANGE INTERACTION IN ALLOYS WITH CERIUM IMPURITIES. Coqblin, B.; Schrieffer, J. R. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 185: 847-53 (Sept. 10, 1969).

Starting with the Anderson model for the 4 f^1 configuration of cerium, the transformation of Schrieffer and Wolff is performed, taking into account combined spin and orbit exchange scattering. The resultant interaction Hamiltonian differs qualitatively from the conventional s-f exchange interaction. The Kondo effect, the spin-disorder resistivity, the Ruderman–Kittel interaction, and the depression of the superconducting transition temperature with impurity concentration are worked out for alloys containing cerium impurities on the basis of this new interaction. (auth)

3465 MAGNETIC RESISTIVITY AND MAGNETIC TRANSITIONS IN RARE-EARTH ALLOYS. Yang, Tien-tsai; Robinson, Lawrence Baylor (Univ. of California, Los Angeles). Phys. Rev., 185: 743-51(Sept. 10, 1969).

The spin-disorder resistivities and the magnetic phase transitions in gadolinium–dysprosium alloys have been investigated experimentally, and the corresponding effects of pressure have been determined. The experiments involved measuring the change in the anomalies in the resistance of samples as a function of temperature and pressure. The resistivities of the metals provide evidence of magnetic transitions, through changes of slope in the resistivity–temperature curves at the critical temperatures. Therefore, the spin-disorder resistivities and the magnetic transitions both under atmospheric and hydrostatic pressures can be obtained from the resistance–temperature curves. The spin-disorder resistivity ρ_{mag} of these alloys is proportional to $3\pi Nm/(2\hbar^2 E_F)V^2(g-1)^2J(J+1)$, where g is the Lande g factor, J is the total angular momentum quantum number, V is an intra-atomic exchange integral, and E_F is the Fermi energy. The quantity ρ_{mag} was experimentally observed to increase with the increasing Gd composition and pressure. In the Rudermann–Kittel theory, the Curie temperature T_C of these alloys is proportional to the quantity $(g-1)^2J(J+1)V^2/(E_F)\Sigma_R\Phi(2k_FR)$, where $\Phi(2k_FR) = (2k_FR \cos 2k_FR - \sin 2k_FR)/(2k_FR)^4$. The quantity (T_C/ρ_{mag}) was experimentally observed to increase and then decrease as a function of composition with the peak value near 60 at. % Gd–40 at. % Dy, thus indicating that the quantity $\Sigma_R\Phi(2k_FR)$, which is proportional to (T_C/ρ_{mag}), passes through a similar maximum. With the application of pressure T_C for Gd-rich alloys decreased, whereas T_C for the Dy-rich alloys appeared to increase first and then to decrease. The variations of T_C with pressure are explained by the relationship between $\Sigma_R\Phi$ and the c/a ratio of the crystal. It is thus concluded (tentatively) that the quantity $\Sigma_R\Phi$ passes through a peak value as a function of both pressure and composition. (auth)

3466 MAGNETIC AND ELECTRICAL PROPERTIES OF DILUTE SOLUTIONS OF PRASEODYMIUM IN LANTHANUM. Loginov, G. M.; Vedernikov, M. V. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 11: 845-6(Oct. 1969).

Translated from Fiz. Tverd. Tela, 11: 1037-9(Apr. 1969).

In order to study the anomalous drop in the electrical resistivity ρ at 0 to 10% Pr, the magnetic susceptibility of La–Pr solid solutions was measured at 80 to 300°K over the composition range. The Curie–Weiss constants are given, and it is shown that the effective magnetic moment of Pr atoms increases in the 0–10 wt % Pr region, indicating that an exchange interaction between the conduction electrons and magnetic impurity atoms is occurring. (D.L.C.)

3467 THEORY OF THE VIBRATIONAL SPECTRA OF HEXAGONAL METALS. Brovman, E. G.; Kagan, Yu.; Kholas, A. Sov. Phys.-Solid State (Engl. Transl.), 11: 733-40(Oct. 1969).

Translated from Fiz. Tverd. Tela, 11: 896-906(Apr. 1969).

The vibrations of the hexagonal metals Be, Mg, and Zn are treated on the basis of a theory previously developed by the authors. The long-range interaction between ions via electrons is described using the pseudopotential method, and the short-range interaction is described using three parameters. The essentially different roles of covalency in the metals investigated are discussed. A detailed comparison between theory and neutron scattering experiments is made. (auth)

3468 OPTICAL ABSORPTION MEASUREMENTS OF TANTALUM, TUNGSTEN, RHENIUM, AND PLATINUM IN THE EXTREME ULTRAVIOLET. Haensel, R. (Univ. of Hamburg); Radler, K.; Sonntag, B.; Kunz, C. Solid State Commun., 7: 1495-7(Oct. 15, 1969).

The absolute absorption coefficient of Ta, W, Re, and Pt was determined in the photon energy range 30 to 600 eV by use of synchrotron radiation at the 7.5-GeV electron synchrotron DESY. The most prominent structure is a broad double peak, which is caused by transitions from the 5p shell into the empty d states of these transition metals. (auth) (UK)

3469 MAGNETIC STRUCTURE OF $HoAg_2$. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys., 51: 3882-5 (Nov. 1, 1969).

The tetragonal body-centered $HoAg_2$ has been shown by neutron powder diffraction to become an antiferromagnet with the Néel temperature of 5.7°K. The magnetic spin alignment is represented by a static longitudinal wave propagating along the a axis of the face-centered alternative of the chemical lattice. The wavelength of this static spin wave is 1.21 times (the face-centered a spacing), being incommensurable with the lattice repetition. Below 4.6°K, a linear-transverse spin wave being polarized in the c-axis direction develops with the propagation direction and wavelength identical to the coexisting longitudinal wave. The maximum and rms moments in Bohr magnetons extrapolated to 0°K are, respectively, 7.5 and 5.3 for the longitudinal wave and 5.0 and 3.5 for the transverse wave. The maximum composite moment at 0°K is $9.0 \pm 0.2\ \mu_B$, while the free Ho^{3+} ion should yield 10 μ_B. (auth)

3470 MAGNETIC STRUCTURES OF $DyAu_2$ AND $DyAg_2$. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys., 51: 3877-82(Nov. 1, 1969).

Neutron-powder-diffraction study has shown that, upon cooling, $DyAu_2$ (tetragonal, isostructural to $MnAu_2$) exhibits the onset of antiferromagnetism at $T_N(\alpha) = 33.8$°K and a first-order-like magnetic transition at $T_N(\beta) = 25.5$°K. The moment alignment between $T_N(\alpha)$ and $T_N(\beta)$ is represented by a static linear-transverse spin wave propagating along the a axis (the face-centered description) and polarized in the direction of the c axis. The wavelength of this modulation wave is 1.21 times (the a spacing), being incommensurable with the chemical repetition. At $T_N(\beta)$, the modulation wavelength becomes abruptly equal to the a spacing with a discontinuous increase in the rms ordered moment but without change in

the moment direction. This commensurated magnetic structure persists down to 1.7°K and the saturation ordered moment is 9.2 μ_B. The $DyAg_2$ structure is analogous to $DyAu_2$ and characterized by $T_N(\alpha) = 15.0°K$; the incommensurate moment wavelength, 1.17a; $T_N(\beta) = 9.5°K$; and the saturation ordered moment, 7.4 μ_B, being much smaller than 10.0 μ_B of the free Dy^{3+} ion. The crystallographic data at 300-5°K are also presented. (auth)

3471 THEORY OF THE HEAT CAPACITY OF POLYCRYSTALLINE GRAPHITE AT VERY LOW TEMPERATURES: FINITE-LATTICE CONTRIBUTION. Fujita, Shigeji; Bugl, Paul (State Univ. of New York, Buffalo). Phys. Rev., 185: 1094-8(Sept. 15, 1969).

Recent measurements of the heat capacity of polycrystalline graphite at liquid-helium temperatures indicate an abnormal enhancement in the term linear in the absolute temperature with decreasing extent of graphitization. A cause for this anomaly is sought by considering the elastic vibrations of a finite lattice. It is shown that if a platelike crystallite with a thickness of about 100 Å vibrates in the direction perpendicular to the plane of the plate, its contribution to the linear term in the heat capacity at very low temperatures is of the same order of magnitude as the observed excess linear heat capacity. Since polycrystalline graphite is known to be composed of flakelike crystallites, it is argued that an important, and possibly the main, cause of the abnormal enhancement is this oscillation of fine crystallite plates. (auth)

3472 LOW-FIELD HALL COEFFICIENT OF INDIUM. Garland, James C. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-2150. Phys. Rev., 185: 1009-16(Sept. 15, 1969). (NYO-2150-52).

Measurements are reported of the magnetic-field and temperature dependence of the Hall coefficient of both single-crystal and polycrystalline indium in the regime characterized by $\omega_c\tau < 1$. Measurements were performed at temperatures below 4.5°K using the helicon-wave technique. The normally positive Hall coefficient was observed to reverse sign at fields below a few hundred gauss with the field H oriented along the [100] and [111] crystal axes. The magnitude of the "crossing field" H_0 as well as the zero-field coefficient R(0) was observed to decrease with increasing temperature. The results were analyzed in terms of a two-band model of the Hall coefficient and it is concluded that the ratio of the electron relaxation time to the hole relaxation time is less than unity and decreases with increasing temperature. (auth)

3473 LATTICE DYNAMICS OF BERYLLIUM USING A PSEUDOPOTENTIAL APPROACH. Sahni, V. C.; Venkataraman, G. (Bhabha Atomic Research Centre, Bombay). Phys. Rev., 185: 1002-9(Sept. 15, 1969).

The lattice dynamics of Be is discussed within the framework of the local pseudopotential approximation. Calculations are made in the first instance using a basic pseudopotential computed from the orthogonalized-plane-wave band-structure results of Loucks and Cutler. Comparison with experimental phonon dispersion relations shows, however, poor agreement. Calculations are also made using Heine–Animalu model potentials, with similar results. Finally, the experimental data are inverted to obtain an experimental pseudopotential. The latter is used to make a band-structure calculation, and the resulting Fermi surface is compared with that derived from de Haas–van Alphen experiments. (auth)

3474 TRANSFER OF POLARIZATION DUE TO MAGNETIC INTERACTION OF NUCLEI IN MONOCRYSTAL. Vdovin, A. I.; Podgoretskii, M. I.; Smirnov, S. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 248-50(Aug. 1969). (In Russian).

The behavior of a spin system in external electric and magnetic fields near the energy-level crossing points is considered. In particular, some features of this behavior at slow and fast variation of magnetic field due to the spin reorientation effect, are analyzed. The case of two spins is considered in detail, and the generalization for the case of any number of interacting spins is performed. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 2266 and 3249.

3475 HYPERFINE INTERACTION IN EUROPIUM–TIN INTERMETALLIC COMPOUNDS. Loewenhaupt, M.; Huefner, S. (Freie Univ., Berlin). Phys. Lett., 30A: 309-10(Nov. 3, 1969).

The hyperfine interactions at the europium and the tin sites have been measured in the intermetallic compounds $EuSn_3$ and EuSn by the Moessbauer effect. (auth)

Theoretical Physics

Refer also to abstracts 3240, 3711, 3728, 3729, and 3760.

3476 PHASE EQUATION IN QUANTUM MECHANICS. Ronveaux, Andre (Univ., Montreal). Amer. J. Phys., 37: 135-41(Feb. 1969).

The so-called phase equation is established in a general way for one-dimensional, linear second-order differential equations and for 2 × 2-linear differential systems. Systematic derivations give phase equations for particular quantum mechanical problems. New results are obtained using elementary mathematical tools, and some problems particularly well adapted for the phase method are suggested. (auth)

3477 PROPERTIES OF THE DISCRETE AND CONTINUOUS SPECTRUM OF A CENTRAL POTENTIAL UNDER SCALING. Ronveaux, Andre (Univ., Montreal). Amer. J. Phys., 37: 142-6(Feb. 1969).

Transformation properties of the phase shift and the scattering length corresponding to a charge in the scale of length for the central potential V(r) are established. They are compared with the equivalent relations for the discrete spectrum of V(r). Corresponding variational relations emphasize the strong correlation between the strength and the range of the potential. Using dimensional analysis, one can predict the dependence on the scattering coefficients of the strength or the cutoff parameters in the potential. (auth)

3478 NEW METHOD OF REMOVAL OF THE DIVERGENCE IN THE BORN SERIES. Michalik, B. (Inst. of Plasma Physics, Prague). Ann. Phys. (N. Y.), 55: 41-60(Oct. 15, 1969).

The divergence of the Born series is overcome by a new method presented here. The state vector is transformed into a new one for which the perturbation series already converges. The choice of transformation vectors appearing in the theory is discussed and ideal choice is found. The previously published distortion operator method corresponds for partial waves to a special choice of the transformation vector (not ideal). The method is not limited to problems of quantum theory, but is applicable to an arbitrary Fredholm integral equation of the second kind. (auth)

3479 WIGNER QUANTUM DENSITY FUNCTION IN THE CLASSICAL LIMIT. DEVELOPMENT OF A THREE-DIMENSIONAL WKBJ-TYPE SOLUTION. Schipper, J. F. (TRW Systems, Redondo Beach, Calif.). Phys. Rev., 184: 1283-1302 (Aug. 25, 1969).

The one-dimensional Wigner quasiprobability function is considered rigorously in the classical limit ($\hbar \to 0$). With the implicit $\hbar$-dependence of the wave function ψ ignored in the integral representation, this limit differs from $|\psi(q)|^2\delta(p)$ by terms $o(\hbar)/\hbar$. With the implicit $\hbar$ dependence of ψ accounted for (as it should be), rigorous asymptotic methods are applied, with the results that: (1) in the "classically allowed" region, the limit is an asymptotic exponential function of q, multiplied by an energy-conserving δ function; (2) in the "nonclassically allowed" region, this limit is zero. The stationary-phase approach leads nowhere in this regard. A WKBJ-type solution for the radial Schrödinger equation is developed, with rigorous error bounds in the different situations. The Wigner function is computed for an ensemble of one-dimensional harmonic oscillators, and an associated phase-space "density matrix" is constructed therefrom. This is compared with the Slater sum for the ensemble — in general, and in the particular cases of high temperature and of $\hbar \to 0$; where $\hbar \to 0$, the asymptotic behavior of the Wigner function is explicitly manifest. (auth)

3480 MEGAOERSTED FIELDS AND THEIR RELATION TO THE PHYSICS OF HIGH ENERGY DENSITY. Knoepfel, H. (EURATOM–CNEN, Frascati, Italy). pp 467-83 of Physics of Solids in Intense Magnetic Fields. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969.

From 1st Chania Conference, Chania, Greece. See CONF-670735.

The interaction of megaoersted fields with metallic conductors results in the liberation of thermal or kinetic energies which may attain a density of 1 MJ/cm³. By the acceleration of metallic projectiles it is possible to go even further, but in practice it will be extremely difficult to surpass the velocity of about 5 cm/μsec for condensed matter. Other more indirect processes not mentioned here exist, which allow one to convert or even further concentrate the already-large energy density of megaoersted fields. As an example we may mention the compression and heating of a hydrogen plasma through these fields (¹) or the acceleration of extremely powerful electron beams in betatron-like magnetic flux compression devices. 27 references. (auth)

3481 WAVE MECHANICS. Ludwig, Gunter. Selected Readings in Physics. New York, Pergamon Press, 1968. 235p. 21s.

The historical development and general quantum theory are discussed in part I. Part II contains 8 general papers on quantum theory. Four of the papers were written by Schroedinger, one from de Broglie, 1 from Heisenberg and 2 by Born. (M.O.W.)

3482 NEW FORMULATION OF STOCHASTIC THEORY AND QUANTUM MECHANICS. de la Pena-Auerbach, L. (Univ. Nacional de Mexico, Mexico City). J. Math. Phys. (N. Y.), 10: 1620-30(Sept. 1969).

The theory of stochastic motion is formulated from a new point of view. It is shown that the fundamental equations of the theory reduce to Schrödinger's equation for specific values of certain parameters. A generalized Fokker–Planck–Kolmogorov equation is obtained; with other values of the parameters, certain approximations reduce this to the Smoluchowski equation for Brownian movement. In particular, the potential function in the Schrödinger equation differs in the two cases. The usual uncertainty relations appear in a natural way in the theory, but in a broader context. A single theory thus covers both similarities and differences between quantum-mechanical and Brownian motion. Furthermore, possibilities for broadening nonrelativistic quantum mechanics are brought out and, as an example, the possible corrections due to non-Markoffian terms are briefly studied. (auth)

3483 CRITICAL-POINT SINGULARITIES OF THE PERTURBATION SERIES FOR THE GROUND STATE OF A MANY-FERMION SYSTEM. Baker, George A. Jr.; Kahane, Joseph (Brookhaven National Lab., Upton, N. Y.). J. Math. Phys. (N. Y.), 10: 1647-60(Sept. 1969).

It is shown that the many-fermion ground-state energy with an attractive potential has a critical singularity. This singularity destroys the validity of "low-density" approximations. One also finds that the K-matrix formalism is, in principle, not applicable to attractive potentials because of the presence of "Emery singularities." An R-matrix formalism is introduced which is numerically very close to the K matrix and free from manifest "Emery singularities." A model calculation is performed on the lattice gas to try to anticipate what quality of results can be expected from summing an R-matrix expansion with fixed density. (auth)

3484 QUANTUM-MECHANICAL CONJUGATE OF THE HAMILTONIAN OPERATOR. Razavy, M. (Univ. of Alberta, Edmonton). Nuovo Cim., 63B: 271-308(Sept. 11, 1969).

Conjugate functions of various classical Hamiltonians are studied and different methods for their construction are presented. From these classical functions, for many dynamical systems, Hermitian operators can be found which depend linearly on time and are conjugates of Hamiltonian operators. The eigenvalues of conjugate operators, under certain conditions, represent the result of measurement of time in nonrelativistic quantum mechanics. Because of this property "time operators" may be used to study the quantum theory of microscopic clocks and to determine their accuracy. For noninteracting relativistic particles with spin zero and spin one-half a direct method of obtaining time operator is given. These conjugate operators have been used to derive well-known relations of the time delay and the rate of change of phase shift with energy in scattering theory. (auth)

3485 THE THREE-DIMENSIONAL, QUANTUM-MECHANICAL, ANISOTROPIC-HARMONIC OSCILLATOR. Rosenberg, Harvey J. (Queens Coll., New York. New York Univ., N. Y.). Amer. J. Phys., 37: 839-40(Aug. 1969).

Mathematical details for deriving the anisotropic-harmonic oscillator are presented. Matrix elements of r^2 are found by writing $r^2 = (x + iy)(x - iy) + z^2$, and summing over all intermediate states. (M.O.W.)

3486 APPARENT EFFECT OF PHOTONS IN A WAVE-MECHANICAL ACTION-AT-A-DISTANCE THEORY. Leiter, D. (Boston Coll., Chestnut Hill, Mass.). Nuovo Cim., 63A: 1087-1100(Oct. 21, 1969).

A model one-dimensional theory of wave-mechanical, simple harmonic oscillators interacting through a scalar "action-at-a-distance" type of retarded coupling is studied. The resulting nonlinear wave-mechanical theory is shown to contain the apparent effects of scalar "photons" independent of recourse to any "second-quantization" formalism. This is done by showing that the "measurement radiation" inherent in the theory is emitted and absorbed effectively in quanta of $\hbar\omega$, even though the electric interactions are classical in nature. Spontaneous transitions as well as induced transitions are properly accounted for, and if we treat an aggregate of oscillators in statistical equilibrium with each other, the corresponding "measurement radiation" observed by the K-th oscillator is distributed according to a formula similar to that of the Planck black-body radiation formula. (auth)

3487 CHERENKOV RADIATION OF A DIRAC MONOPOLE. Mukhtarov, A. I.; Niyazova, E. N. Opt. Spectrosc., (USSR) (Engl. Transl.), 26: 208-10(Mar. 1969).

Translated from Opt. Spektrosk., 26: 379-82(Mar. 1969).

For the purpose of investigating the possibility of experimentally observing hypothetical particles carrying a magnetic charge (the monopole), the characteristic polarization properties that the Cherenkov radiation from particles having both magnetic and electric moments must possess were examined. (auth)

3488 VARIATIONAL PRINCIPLES IN DYNAMICS AND QUANTUM THEORY. THIRD EDITION. Yourgrau, W.; Mandelstam, S. London, Pitman, 1968. 201p. 40s.

The following topics are discussed: History of subject; Fermat's principle of least time; principle of least action of Maupertuis; development of principle by Euler and Lagrange; equations of Lagrange and Hamilton; Hamilton's principle and the Hamilton–Jacobi equation; contact transformations and Hamilton's canonical equations; electrodynamics in Hamiltonian form; variational principles in classical mechanics; relation between variational principles and older form of quantum theory; variational principles and wave mechanics; principles of Feynman and Schroedinger in quantum mechanics; variational principles in hydrodynamics; significance of variational principles in natural philosophy. Appendices include: Proof of Euler–Lagrange conditions for an integral to be stationary; variational principles and chemical reactions. (UK)

3489 NEW METHOD OF QUANTUM MECHANICS. Tunazima, Nagatoshi. Tokyo, The Sanshusha Press Company, 1969. 68p.

The new method of quantum mechanics is developed in which the movement of particles is free from the probability and the movement of the electron in the hydrogen atom is determined by the time function. It is stated that the quantum constant is free from the probability consideration and the new idea on space should be considered. In the application of this consideration, the new method of celestial mechanics is developed in the matrix space. (M.O.W.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 3550.

3490 (TID-25251) REPORT ON HIGH ENERGY PHYSICS, JUNE 1969. (High Energy Physics Advisory Panel (AEC)). June 1969. 164p. Dep. GPO $1.50.

A review is given of the current status of high-energy physics research and on the resources and facilities needed to pursue this fundamental field of research with recommendations as to the future program for the coming decade. The topics covered are conclusions, recommendations, and future projections, budgetary implications, recent progress in high-energy physics, accelerators, subsidiary equipment for high-energy physics experiments, analysis of data on photographic film, cosmic ray studies in elementary particle physics, university participation in high-energy physics research, and international collaboration. Appendices on new accelerator technology, high energy physics manpower survey, and bubble chamber data analysis in the U. S. are included. It is concluded that U. S. high energy physics research can be maintained at a vigorous and productive level with an average cost increase of about 8% per annum over the next decade. (C.E.S.)

Electromagnetic

Refer also to abstracts 2524 and 3583.

3491 (DESY-69/39) MEASUREMENTS OF THE LONGITUDINAL AND LATERAL DEVELOPMENT OF ELECTROMAGNETIC CASCADES IN LEAD, COPPER, AND ALUMINUM AT 6 GeV. Bathow, G.; Freytag, E.; Tesch, K.; Kajikawa, R.; Koeberling, M. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct. 1969. 18p. Dep. CFSTI (U. S. Sales Only).

Electromagnetic cascades in lead and copper, initiated by 6-GeV electrons, have been calculated by the Monte-Carlo method. These calculations are used for shielding design or design of quantameters and shower counters. Only the calculations of the longitudinal development of the cascade have been checked by an experiment performed at DESY. Concerning the lateral distribution, only measurements up to 1 GeV have been done. They seem to indicate a slower radial decrease than given by the calculations. Present measurements are intended to be a more stringent check of the 6-GeV Monte-Carlo calculations, especially regarding the radial distribution. By means of radiophotoluminescence-glasses, the energy deposition in lead, copper and aluminum was measured. To avoid errors, the dimensions of the dosimeters used should be small to permit the measurement of the steep gradient of the energy deposition near the shower axis. They should be completely surrounded by material without any slit or hole, especially in radial direction. With the dimensions of the glasses used (1mmϕ × 6mm), the transition effect is assumed to be negligible. For low-energy electrons of the shower, the conditions for using the Bragg-Gray principle are not fullfilled. However, it is shown that the energy deposition in the glass can be assumed proportional to the energy deposition in the material, the factor being constant within the whole shower. Therefore the measurements are normalized to the total primary beam energy. The number of primary electrons was monitored by a secondary emission monitor. The beam profile was measured by a plate of radiophotoluminescence glass. In three runs with different numbers of electrons the shower development could be measured, covering 6 orders of magnitude of the energy deposition. The results of the measurements for the three materials are shown. The results for lead and copper are compared with the Monte Carlo calculations. The longitudinal development agrees within the experimental error of 5% with the calculations in both cases. Comparing the radial distributions, the finite beam profile must be taken into account; the calculated curves were folded with the measured profile. Good agreement is found up to 4 cm radius. Within this range the dose decrease by about three orders of magnitude. At greater lateral distances, differences between measurements and calculations greater than experimental errors are found, the measured values being generally higher than the calculated ones. The maximum difference, roughly a factor of 2, occurs in lead at small shower depth. These deviations cannot be explained by systematic experimental errors. (auth)

3492 (NSRDS-NBS-29) PHOTON CROSS SECTIONS, ATTENUATION COEFFICIENTS, AND ENERGY ABSORPTION COEFFICIENTS FROM 10 keV TO 100 GeV. Hubbell, J. H. (National Bureau of Standards, Washington, D. C.). Aug. 1969. 84p. GPO $0.75.

Previous NBS tabulations are updated and extended. A tabulation of the attenuation coefficient for 23 elements ($_1$H to $_{92}$U) between 10 keV and 100 GeV and a tabulation of the energy absorption coefficient for air, water, and 18 elements between 10 keV and 10 MeV, and for air, water, and 7 elements up to 100 MeV are given. Detailed information on the predominant processes (photoelectric absorption. Compton scattering and pair production) and a brief discussion of other processes which combine to give the attenuation coefficient are presented. Theoretical and experimental data are reviewed, and auxiliary tables and approximation formulas are given. Tabulations of cross sections for the predominant processes between 10 keV and 100 GeV are tabulated for 23 elements and for 13 compounds and mixtures. (auth)

3493 PROTON-PROTON BREMSSTRAHLUNG AT 100 MeV. Sannes, Felix. Montreal, McGill Univ., 1968. Thesis.

The proton–proton bremsstrahlung cross section is measured in order to test the predictions of several phenomenological nucleon–nucleon potentials. The bremsstrahlung reaction ($p + p = p + p + \gamma$) may be used to investigate the off-energy-shell proton–proton interaction. The various nucleon–nucleon potentials which have been fitted to elastic scattering data (on-energy-shell) must also describe the off-energy-shell nucleon–nucleon interaction. The bremsstrahlung process may therefore serve to discriminate between potentials which fit the elastic data equally well. Measurements of the bremsstrahlung cross section $d^2\sigma/d\Omega_1 d\Omega_2$ are made by detecting the two final-state protons in coincidence at equal angles on opposite sides of the incident proton beam. Cross sections of 3.77 ± 0.23, 5.14 ± 0.22, 9.01 ± 0.33, and 18.83 ± 1.15 μb/sr^2 are obtained at angles of 25, 30, 35, and 40° respectively. The energy of the incident protons is 99.0 ± 0.2 MeV. The angular distributions of the γ-rays are determined kinematically. The measured cross sections are compared with theoretical cross sections calculated from several different nucleon–nucleon potentials. The present data are best represented by the hard-core Hamada–Johnston potential. (Diss. Abstr. Int., B)

3494 COINCIDENCE MEASUREMENTS OF SINGLE-PION ELECTROPRODUCTION NEAR THE $\Delta(1236)$ RESONANCE. Mistretta, C.; Appel, J. A.; Budnitz, R. J.; Carroll, L.; Chen, J.; Dunning, J. R. Jr.; Goitein, M.; Hanson, K.; Imrie, D. C.; Wilson, Richard (Harvard Univ., Cambridge, Mass.). Phys. Rev., 184: 1487-1507(Aug. 25, 1969).

Differential cross sections for the reactions $e^- + p \rightarrow e^- + p + \pi^0$ and $e^- + p \rightarrow e^- + n + \pi^+$ were measured near the $\Delta(1236)$ resonance at four-momentum transfers of 0.05, 0.13, 0.25, and 0.4 (GeV/c)^2. A few measurements of the π^+ angular distribution were obtained at a four-momentum transfer of 0.6 (GeV/c)^2. Cross sections for the π^0 reaction are compared with dispersion-theory predictions at several pion-nucleon c.m. energies for each four-momentum transfer. A phenomenological analysis of the π^0 results leads to the determination of the magnetic dipole and electric quadrupole partial-wave amplitudes and the $\gamma N\Delta$ transition form factor. Evidence is found for the existence of a significant scaler-transverse interference term in the cross section, which is tentatively associated with the resonant scaler quadrupole interaction. Cross sections for π^+ electroproduction are compared with dispersion theories using the pion form factor as a free parameter. The results suggest a form factor similar to that of the proton. A fit to the form-factor results, using the ρ-dominance model, requires $m_\rho = 560 \pm 80$ MeV. The rms pion charge radius is estimated to be $\langle r^2 \rangle^{1/2} = 0.86 \pm 0.14$ F. (auth)

3495 SEARCH FOR MAGNETIC MONOPOLES IN DEEP OCEAN DEPOSITS. Fleischer, R. L. (General Electric Research and Development Center, Schenectady, N. Y.); Hart, H. R. Jr.; Jacobs, I. S.; Price, P. B.; Schwarz, W. M.; Aumento, F. Phys. Rev., 184: 1393-7(Aug. 25, 1969).

High-field magnets and solid-state track detectors were used in an endeavor to extract and observe magnetic monopoles from ferromanganese pavement that was deposited at the bottom of the North Atlantic Ocean during the last 16 million years. The failure to observe poles sets new and restrictive limits on the abundance of monopoles and upon their production cross sections. For proton-nucleon collisions, the new cross sections are $\leq 10^{-41}$ cm^2 if the monopole mass is one proton mass m_p and $\leq 2 \times 10^{-34}$ cm^2 at 1000 m_p. Any magnetic charge up to 60 times Dirac's value of $\hbar c/2e$ could have been detected. The flux of monopoles reach-

ing the ocean floor is less than 4×10^{-18} (cm^2 sec)$^{-1}$ at the 90% confidence level, so that no portion of the cosmic-ray energy spectrum up to $\approx 10^{19}$ eV is composed dominantly of magnetic monopoles. (auth)

3496 SEARCH FOR TRACKS OF MASSIVE, MULTIPLY CHARGED MAGNETIC POLES. Fleischer, R. L.; Price, P. B.; Woods, R. T. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev., 184: 1398-1401 (Aug. 25, 1969).

Massive magnetic monopoles of charge $\geq \hbar c/e$ (twice Dirac's value of the minimum pole strength and half of Schwinger's) would leave tracks in natural minerals, provided they arrive at the earth with sufficient energy. In order to test Porter's hypothesis that the cosmic-ray particles of energy $>10^{17}$ eV are (or include) magnetic monopoles, samples of mica and of obsidian were scanned for the distinctive, long particle tracks which would have been stored over geological times. The failure to find monopole tracks sets an upper limit (90% confidence) of 1.2×10^{-19} monopoles per cm^2 sr sec for penetrating monopoles incident upon the earth and rules out Porter's hypothesis for the charge and mass range within which poles would have been detected. (auth)

3497 PHOTOPRODUCTION OF π^0 ON PROTONS BY POLARIZED γ RAYS. Barbiellini, G. (CNEN, Frascati, Italy); Bologna, G.; Capon, G.; De Zorzi, G.; Fabbri, F. L.; Murtas, G. P.; Diambrini, G.; Sette, G.; De Wire, J. Phys. Rev., 184: 1402-13(Aug. 25, 1969).

The asymmetry $\Sigma(k,\theta^*) = (d\sigma_\perp - d\sigma_\parallel)/d\sigma_\perp + d\sigma_\parallel)$ of the polarized cross sections for π^0 photoproduction was measured at $\theta^* = 90°$ for energies k of the incident photon in the range 230 to 380 MeV. The experiment was performed with the polarized γ-ray beam of the Frascati 1-GeV electron synchrotron. The experimental results are compared with the present theoretical predictions in order to investigate the importance of ω exchange in the t channel and the contribution of the $E_{1+}^{(3)}$ multipole at the 33 resonance. The theory with ω exchange is in the best agreement with the experiment. (auth)

3498 S-WAVE DIPION PRODUCTION BY COLLIDING ELECTRON BEAMS. DeCelles, P. C.; Goehl, J. F. Jr. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-427. Phys. Rev., 184: 1617-21(Aug. 25, 1969).

The feasibility of experimentally determining the S-wave $\pi\pi$ phase shifts in the reaction $e^- + e^- \rightarrow e^- + e^- + \pi^+ + \pi^-$ is investigated. (auth)

3499 MEASUREMENT OF NEUTRAL- AND CHARGE-PION FORM-FACTOR SLOPES. Devons, S. (Columbia Univ., New York); Nemethy, P.; Nissim-Sabat, C.; Di Capua, E.; Lanzara, A. Phys. Rev., 184: 1356-63(Aug. 25, 1969).

In an experiment performed at Columbia University's Nevis cyclotron, the reactions (1) $\pi^0 \rightarrow \gamma + e^+ + e^-$ and (2) $\pi^- + p \rightarrow n + e^+ + e^-$ for π^- at rest. Using a system of counters and spark chambers, pairs with an opening angle near 120° were selected. The invariant-mass spectrum of the pairs (1) in 2200 π^0 decays and (2) in 400 radiative captures were analyzed. For the π^0 form-factor slope, $a = (+0.01 \pm 0.11)/m_{\pi^0}^2$ was found. The charged-pion form-factor slope was obtained for time like momentum transfers of the order of m_π. The result for the pion charge radius is $r_\pi < 1.9$ F with a 90% confidence level. (auth)

3500 MUON–PROTON INELASTIC SCATTERING, q^2 LESS THAN 1.2 (GeV/c)^2. Dieterle, B. D. (Stanford Univ., Calif.); Braunstein, T.; Cox, J.; Martin, F.; Toner, W. T.; Perl, M. L.; Zipf, T. F. Phys. Rev. Lett., 23: 1187-91(Nov. 17, 1969).

The inelastic scattering of muons was measured using positive muons of momentum 10 GeV/c incident upon a liquid-hydrogen target. Values of the differential cross section and of the virtual photon-photon absorption cross section for $|q|$ in the range 0.05 to 1.2 (GeV/c)^2 and for equivalent photon laboratory energies of 0.6 to 6.5 GeV are presented. (auth)

3501 MUON–PROTON INELASTIC SCATTERING AND VECTOR DOMINANCE. Perl, M. L. (Stanford Univ., Calif.); Braunstein, T.; Cox, J.; Martin, F.; Toner, W. T.; Dieterle, B. D.; Zipf, T. F. Phys. Rev. Lett., 23: 1191-5(Nov. 17, 1969).

Results from muon-proton inelastic scattering are used to investigate the form of $\sigma_{exp}(q^2,K)$, the quantity commonly called the "virtual photon-proton total cross section." Fits to σ_{exp} were made for photon energies $0.6 \leq 6.5$, and 4-momentum transfer squared $|q^2|$ up to 1.2 (GeV/c)^2. Measurements of the real photon-proton total cross section $\sigma_{\gamma p}(K)$ are included in the fits. The forms of rho-dominance theory which predict $\sigma_{exp}(q^2,K) = \sigma_{\gamma p}(K)/(1 + |q^2|/m_\rho^2)$ are in agreement with the data. (auth)

3502 γp INTERACTIONS AT 5.25 GeV. Ballam, J.; Chadwick, G. B.; Guiragossian, Z. G. T.; Levy, A.; Menke, M.; Seyboth, P.; Wolf, G. (Stanford Univ., Calif.). Phys. Lett., 30B: 421-5(Nov. 10, 1969).

Photoproduction of resonances was studied using positron annihilation radiation at 5.25 GeV in the SLAC 40-inch hydrogen bubble chamber. Results are presented on the nonstrange particle events and related to the vector dominance model. (auth)

3503 TOTAL PHOTOABSORPTION CROSS SECTIONS UP TO 18 GeV AND THE NATURE OF PHOTON INTERACTIONS. Caldwell, D. O. (Univ. of California, Santa Barbara); Elings, V. B.; Hesse, W. P.; Jahn, G. E.; Morrison, R. J.; Murphy, F. V.; Yount, D. E. Phys. Rev. Lett., 23: 1256-60(Nov. 24, 1969).

The smallness of nucleon photoabsorption would imply total photonucleus cross sections which vary as the number of nucleons in the nucleus, but if ρ dominance is correct the resulting strong interactions would take place primarily with the surface nucleons. At Stanford Linear Accelerator Center we have measured the photoabsorption in H, D, C, Cu, and Pb and have found cross sections which vary as $\sim A^{0.9}$ indicating that the photon interacts, at least partially, as a strongly interacting particle. (auth)

Weak

3504 A MEASUREMENT OF THE K^+ BRANCHING RATIOS: $K_{\mu 2}^+$, $K_{\pi 2}^+$, $K_{\mu 3}^+$, $K_{e 3}^+$. Dairiki, Ned Tsuneo. Berkeley, Calif., Univ. of California, 1968. 94p.

Thesis.

Mesons (K^+) in a separated momentum-analyzed beam were brought to rest in a scintillator target which served as a source point for a broad-range magnetic spectrometer. Pions, muons, and electrons from the various decay modes of the K^+ were identified by range and momentum and a measurement of the relative branching ratios ($K_{\mu 2}^+$, $K_{\pi 2}^+$, $K_{\mu 3}^+$, $K_{e 3}^+$) was made. Using a compiled branching ratio value for the $(\tau + \tau')$ modes of (7.26 ± 0.09)% the resulting values of the branching ratios were: $K_{\mu 2}^+$ (63.4 ± 0.99)%, $K_{\pi 2}^+$ (21.6 ± 0.72)%, $K_{\mu 3}^+$ (3.51 ± 0.80)%, and $K_{e 3}^+$ (4.12 ± 0.36)%. The measurement is compared with results of other experiments. (Diss. Abstr. Int., B)

3505 MEASUREMENT OF THE MUON POLARIZATION VECTOR IN $K^+ \rightarrow \pi^0 + \mu^+ \nu$. Cutts, D. (Univ. of California, Berkeley); Stiening, R.; Wiegand, C.; Deutsch, M. Phys. Rev., 184: 1380-92(Aug. 25, 1969).

The decay $K^+ \rightarrow \pi^0 + \mu^+ + \nu$ ($K_{\mu 3}$) was studied in a spark-chamber experiment at the Bevatron. The data consist of 3133 events μ-e decays and complete kinematics for $K_{\mu 3}^+$. The muon polarization vector was determined from the angular distribution of the decay electrons and this measurement was related to a determination of the vector form-factor ratio, $\xi = f_-/f_+$. The data are statistically consistent with the assumption that ξ does not depend on momentum transfer. Assuming ξ constant, the result is $\xi = (-0.9 + 0.5/-0.4) + i\,(-0.3 \pm 0.5)$. From an analysis of the data imposing the constraint that ξ be real, $\xi = -0.95 \pm 0.3$ is obtained. The muon polarization along the direction predicted by these values for ξ is 0.9 ± 0.1. In a calibration experiment, the muon longitudinal polarization in the decay $K^+ \rightarrow \mu^+ + \nu$ is found to be -1.0 ± 0.1. (auth)

3506 STRUCTURE FACTORS IN INELASTIC NEUTRINO SCATTERING. Budagov, I.; Cundy, D. C.; Franzinetti, C.; (and others) (CERN, Geneva). Phys. Lett., 30B: 364-8(Oct. 27, 1969).

Neutrino scattering cross sections in the deep inelastic continuum were determined and shown to exhibit the point-like behavior or scale invariance, previously observed in electroproduction experiments. The structure functions display the features predicted by the Pomeron exchange model for virtual W-scattering. Their magnitudes are compared with various theories. (auth)

3507 FINAL STATE INTERACTIONS AMONG THE DECAY PRODUCTS OF THE HYPERNUCLEI ${}^{8}_{\Lambda}$Li AND ${}^{12}_{\Lambda}$B. Vilain, P. (Univ. Libre, Brussels); Wilquet, G.; Sacton, J.; Harmsen, D. M.; Davis, D. H.; Wickens, J. H.; Gajewski, W. Nucl. Phys., B13: 451-66(1969).

The results of a study of the decay of the ${}^{8}_{\Lambda}$Li and ${}^{12}_{\Lambda}$B hypernuclei are presented. The ${}^{8}_{\Lambda}\text{Li} \rightarrow \pi^- + {}^{8}\text{Be}^* \rightarrow \pi^- + {}^{4}\text{He} + {}^{4}\text{He}$ and ${}^{12}_{\Lambda}\text{B} \rightarrow \pi^- + {}^{12}\text{C}^* \rightarrow \pi^- + {}^{4}\text{He} + {}^{4}\text{He} + {}^{4}\text{He}$ modes were investigated in detail. New information on the decay mechanism of the 16.11 MeV state of ^{12}C was obtained. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 3701, 3841, and 3842.

3508 (KFK-1012) EXPERIMENTAL INVESTIGATION OF THE n–p AND p–p FINAL STATE INTERACTION IN THE THREE BODY REACTION $p + d \rightarrow p + p + n$ WITH 52-MeV DEUTERONS.

Brueckmann, H.; Gehrke, W.; Kluge, W.; Matthaey, H.; Schaenzler, L.; Wick, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). July 1969. 18p. (CONF-690710-3). Dep. CFSTI (U.S. Sales Only).

From International Conference on the Three-Body Problem, Birmingham, England.

The reaction d + p → p + p + n was studied in kinematically complete experiments at a deuteron bombarding energy of 52 MeV. Two of the outgoing nucleons (two protons or the neutron and one of the protons) were detected in coincidence. The reaction was investigated at different sets of angles where a n + p respectively a p + p final state interaction is expected to be the dominating reaction mechanism. The n + p final state interaction data were analyzed assuming incoherent contributions of an n + p singlet and an n + p triplet final state interaction. Three independent parameters, the singlet scattering length a_S and the two intensities for singlet and triplet scattering were determined by a least square fit to the experimental data. The results for different center of mass angles of the third particle show the dominating singlet final-state interaction in the investigated kinematical region. A surprisingly fair agreement is obtained by comparing the data with calculations based on Watson's theory. The p + p final state interaction data were analyzed assuming only an interaction of two protons in an S state. These data are also compared with calculations based on the Watson model using the effective range approximation. The singlet p–p scattering length extracted from this analysis is $a_{pp} = -(7.5 \pm 0.5)$ f. The fair agreement between this value and the known scattering length of the free p–p scattering shows that the production of S-state proton pairs seems to be the predominant feature of the investigated reaction p + d → p + p + n. (auth)

3509 (PPAR-10) NEUTRON–PROTON CHARGE-EXCHANGE SCATTERING BETWEEN 600 MeV/c AND 2000 MeV/c. Shepard, P. F.; Devlin, T. J.; Mischke, R. E.; Solomon, J. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Mar. 1969. Contract AT(30-1)-2137. 139p. Dep. CFSTI.

N-p elastic differential cross sections in the charge-exchange region were measured for incident neutron momenta between 600 MeV/c and 2000 MeV/c. A secondary neutron beam from the bombardment of a 1½-in. platinum target by the 3-GeV internal proton beam at the Princeton-Pennsylvania Accelerator was scattered from a liquid-hydrogen target. The incident neutron energy was determined by a measurement of flight time over a 108 ft. flight path. The momentum and scattering angle of the recoil proton were measured by a wire-spark-chamber magnetic spectrometer with magnetostrictive readout. Approximately 450,000 elastic events were detected for proton laboratory angles between 0 and 62°. Differential cross sections are presented at fifteen energies. An absolute normalization of the cross sections was achieved by measuring the incident neutron flux with a detector whose efficiency was determined experimentally. (auth)

3510 (PURC-2137-13) n + p → d + γ: A TEST OF TIME REVERSAL INVARIANCE. Technical Report No. 5. Friedberg, Carl E. (Princeton Univ., N. J.). Sept. 10, 1969. Contracts N00014-67-A-0151-001; AT(30-1)-2137. 157p. Dep. CFSTI.

The process n + p → d + γ was investigated at the Princeton Pennsylvania Accelerator as a test of time reversal invariance. The differential and total cross sections obtained were compared with those for the process γ + d → n + p, as a test of reciprocity, for neutron energies between 160 and 640 MeV. The total cross sections measured are in agreement with existing data. The differential cross sections measured are in agreement except in the energy range $520 < T_n < 640$ MeV. (auth)

3511 SCATTERING OF ANTINEUTRONS BY PROTONS. Franklin, A. D.; Socash, R. R. (Univ. of Colorado, Boulder). Contract AT(11-1)-1537. Phys. Rev., 184: 1413-14(Aug. 25, 1969).

The total and elastic cross sections for antineutrons on protons were measured for antineutron momenta from 0.5 to 2.5 GeV/c. The results are in agreement with previous $\bar{p}p$ data at these momenta. (auth)

3512 ANTIPROTON–PROTON ANNIHILATION INTO ELECTRON–POSITRON PAIRS AND GAMMA-RAY PAIRS. Hartill, D. L. (California Inst. of Tech., Pasadena); Barish, B. C.; Fong, D. G.; Gomez, R.; Pine, J.; Tollestrup, A. V.; Maschke, A. W.; Zipf, T. F. Contract AT(11-1)-68. Phys. Rev., 184: 1415-23 (Aug. 25, 1969).

Experimental limits were set on the cross sections for $\bar{p} + p \rightarrow e^+ + e^-$ for antiprotons with incident momenta of 1.47 and 2.40 GeV/c. These results imply upper limits on the magnitude of the proton form factors for timelike four-momentum transfer of 5.1 and 6.6 $(GeV/c)^2$. The reaction $\bar{p} + p \rightarrow \gamma + \gamma$ was studied at the same incident momenta. This process has apparently been observed for incident antiproton momentum of 1.47 GeV/c, while an upper limit for the two-photon annihilation cross section is found at 2.40-GeV/c incident momentum. (auth)

3513 PRODUCTION OF LIGHT FAST FRAGMENTS IN (p–NUCLEUS) INTERACTIONS AT 20 GeV. Alard, Jean-Pierre (Laboratoire de Physique Nucleaire, Clermont-Ferrand, France); Bolta, Jose-Miguel; Cordaillat, Andre; Melia, Joaquin; Motta, Claude; Pfohl, Raymond; Sicre, Alain. Compt. Rend., Ser. B, 269: 212-15(July 28, 1969). (In French).

The description of an experiment designed to study the production of light fast fragments in p-nucleus interactions at 20 GeV is given. The values of the ratios $^3H/^2H$, $^3He/^4He$, and $^3He/^3H$ are deduced from the experimental results. (tr-auth)

3514 DOMINANCE OF POMERON LIKE EXCHANGE IN pp → NNπ AT 19 GeV/c. Boeggild, H. (Univ. of Copenhagen); Hansen, K.; Johnstad, H.; (and others). Phys. Lett., 30B: 369-72(Oct. 27, 1969).

The reactions pp → NNπ are studied at 19 GeV/c and analyzed in terms of the amplitudes with the low mass Nπ system in isospin states ½ and ⅔ respectively. The I = ½ cross section is compared with the corresponding one in πp → ππN at 8 GeV/c. (auth)

3515 POLARIZATION IN DEUTERON–DEUTERON ELASTIC SCATTERING BETWEEN 8 AND 12 MeV. Plattner, G. R.; Keller, L. G. (Univ. of Wisconsin, Madison). Phys. Lett., 30B: 327-8 (Oct. 27, 1969).

The vector polarization in d–d elastic scattering was measured at 8, 10, and 12 MeV. The measured polarization is less than 3%. This is surprising since orbital angular momenta $l > 0$ contribute strongly to the cross section. (auth)

3516 TESTS OF CHARGE-CONJUGATION INVARIANCE IN OTHER THAN WEAK INTERACTIONS. Barshay, Saul (Univ. of Copenhagen. Princeton Univ., N. J.). Phys. Rev. Lett., 23: 1195-8(Nov. 17, 1969).

The possible near degeneracy in mass of recently detected massive neutral boson states with opposite charge conjugation allows for the possibility that a relatively weak C-nonconserving interaction is enhanced in mixing these states. Some observable C-nonconserving effects that are consequences of this mixing are discussed. (auth)

3517 TWO-PRONG EVENTS IN PROTON–PROTON INTERACTIONS AT 8.1 GeV/c. Ginestet, J.; Manesse, D.; Tran Ha Anh; Vignaud, D. (Cen, Saclay, France). Nucl. Phys., B13: 283-93(1969).

About 10,000 two-prong events of 8.1 GeV/c proton-proton interactions in the CERN 2 m bubble chamber were analyzed. Elastic scattering and single-pion production reactions were studied. Cross sections are given for isobar production. An attempt is made to interpret the general features of the pp → pnπ⁺ reaction by the Deck mechanism. The production and the decay of $\Delta^{++}(1236)$ are compared with absorption or π Regge trajectory exchange models. (auth)

3518 ELASTIC pp AND np SCATTERING AT HIGH ENERGIES IN QUASIPOTENTIAL MODEL. Garsevanishvili, V. R.; Goloskokov, S. V.; Matveev, V. A.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 10: 627-36 (Sep 1969). (In Russian).

Experimental data on elastic pp and np scattering at high energies are analyzed based on the results from high-energy scattering obtained in the quasipotential model. (auth)

3519 PRODUCTION OF NEGATIVE PARTICLES BY 70-GeV PROTONS. Bushnin, Yu. B.; Gorin, Yu. P.; Denisov, S. P.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR. CERN, Geneva). Yadern. Fiz.; 10: 585-91(Sep 1969). (In Russian).

The first experimental results of investigation of production of π^--mesons, K^--mesons, and antiprotons by 70 GeV protons on the aluminum target of the Serpukhov proton synchrotron, are presented. The measurements are performed in the region of small angles ($\theta < 15$ mrad) for the momenta of the secondary particles $p > 0.5\ p_0$ (p_0 is the momenta of accelerated protons). The upper limiting estimates for the cross sections of production of antideuterons and of new long-lifetime particles with mass up to 2.2 GeV/c^2, are obtained. Gas Čerenkov counters of high resolution were used to identify the particles. (auth)

Strong (Meson-Induced)

Refer also to abstract 3499.

3520 (BNL-14090) RECENT RESULTS FROM ππ → KK̄ AND KK̄ → KK̄ INTERACTIONS. Lai, Kwan Wu (Brookhaven

National Lab., Upton, N. Y.). June 26, 1969. 13p. (CONF-690521-9). Dep. CFSTI.

From Conference on the π-π and K-π Interactions, Argonne, Ill.

A brief review is given of some important features and new developments in the $K + K \rightarrow K + \bar{K}$ and $\pi + \pi \rightarrow K + \bar{K}$ interactions are given. The quantum numbers of the two interactions, means of obtaining $\pi + \pi \rightarrow \pi + \pi$, $K + \bar{K} \rightarrow K + \bar{K}$, and $\pi + \pi \rightarrow K + \bar{K}$, $G = +1$ states from $\pi + \pi \rightarrow K + \bar{K}$ interactions, $G = \pm 1$ states from $K + \bar{K} \rightarrow K + \bar{K}$ interactions, and virtual meson (K) exchange in a relation of S^* production between $\pi^- + p$ and $\bar{K} + N$ interactions are considered. (J.F.P.)

3521 (DESY-69/37) APPLICATION OF A REGGEIZED MULTI-PERIPHERAL MODEL TO π^-p INTERACTION AT 11 GeV/c. Caso, C.; Conte, F.; Tomasini, G.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1969. 38p. Dep. CFSTI (U. S. Sales Only).

The modified multi-Regge model by Chan, Loskiewicz and Allison (CLA) is used to calculate one-particle distributions of transverse and longitudinal momenta, p_t and p_l^*, and invariant mass distributions of the reactions $\pi^-p \rightarrow N + (n-1)\pi$ with multiplicities n ranging from 3 to 7 and an incident momentum of 11 GeV/c. The model is applied in a way that allows one to distinguish between differently charged pions. In order to account for the experimentally observed neutral pions in the forward direction, one must take for the trajectory with G-parity + 1 the ρ and not the Pomeron used by CLA. A comparison between the multi-Regge calculations and the experiment shows a good overall agreement. A remarkable feature of the reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-\pi^0$ is, that almost no Δ^{2+} production can be observed, when the prediction of the multi-Regge model is taken as representation of the background in the $p\pi^+$ mass plot. However, this does not necessarily mean that no Δ^{2+} production is present, but it might be an indication of the local duality now under discussion. (auth)

3522 (JINR-P1-4611) RESONANCE PRODUCTION IN 4-PRONG π^+p-INTERACTIONS AT 2.34 GeV/c. Angelov, N.; Gramenitskii, I. M.; Kanazirski, Kh.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 26p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A method for determination of the resonance parameters in 4- and 5-body reactions is described. The cross sections for the single production of $N^*_{1238}^{++}$, ρ^0, ω^0 resonances as well as the values of channels for the joint production of $N^*\rho^0$, $N^*\omega^0$, $N^*\eta^0$ resonances at 2.34 GeV/c are presented. The data on cross sections in the region of primary π^+-meson momenta of 1-8 GeV/c are compared. (auth)

3523 (PURC-2137-16) BEAM DUMP EXPERIMENT: UTILIZATION OF MUON POLARIZATION EFFECT IN W SEARCH. Chen, K. W. (Princeton Univ., N. J.). [1965]. Contract AT(30-1)-2137. 4p. Dep. CFSTI.

A proposed experiment using muon polarization in a high-energy beam to search for W particles is described. It is pointed out that the longitudinal polarization of muons from the decay of W should have a direction opposite to that of muons from pion of kaon decay. In the experiment proposed 100-GeV muons are deflected by a solid iron magnet and are stopped in a scintillator-brass spark chamber for polarization analysis. (J.F.P.)

3524 ρ^0 AND f^0 RESONANCE PRODUCTION IN 3.65-GeV/c π^+d INTERACTIONS. Lovell, Lawrence Wheeler. Ann Arbor, Mich., Univ. of Michigan, 1968. 148p.

Thesis.

An experimental study is presented on dipion resonance production in the reactions (1) $\pi^+d \rightarrow p\,p\,\pi^+\pi^-$ (1983 events) and (2) $\pi^+d \rightarrow p\,p\,X^0$ (1392 events). The data were obtained in a 250,000 picture exposure of a 20 in. deuterium bubble chamber. The spectator proton is discussed and the two particle mass spectra are examined for the quasi-two-body production of dipion and pion-nucleon resonances. Reaction (1) is dominated by the ρ^0 and f^0 resonances, 62% and 24% respectively, while the decays of the η^0, ω^0, and f^0 into neutrals are observed in the missing mass (X^0) spectrum of reaction (2). The mass and width of the ρ^0 and f^0 are determined by fitting Breit Wigner resonance forms. The effects of including an angular momentum barrier are discussed. The total and differential cross sections are measured and compared with predictions of the absorption modified one pion exchange model. The relations between the production amplitudes, the density matrix of the ρ^0, and its decay angular distribution are discussed and the density matrix elements and degree of spin alignment measured as a function of mass and momentum transfer. Strong interferences are observed in the decay, attributed to a small S wave background, and its energy dependence measured using an analysis of the form of the interference pattern. No evidence for a proposed S wave resonance, the ϵ^0, is observed in either its interference or decay into neutrals. The isotopic spin of the f^0 is confirmed by a measurement of its branching ratio into neutrals. Strong destructive interferences are observed to be present in the f^0 decay angular distribution. (Diss. Abstr. Int., B)

3525 A STUDY OF 4-PRONG FINAL STATES WITH HIGH-MOMENTUM PROTONS IN 6-GeV/c π^-p INTERACTIONS. Prickett, William Franklin. Bloomington, Ind., Indiana Univ., 1968. 137p.

Thesis.

A study is made of the two reactions $\pi^-p \rightarrow \pi^+\pi^-\pi^-p$ and $\pi^-p \rightarrow \pi^+\pi^-\pi^-\pi^0p$, with an incident π^- momentum of 6.0 GeV/c, and an outgoing proton with a laboratory momentum greater than 1000 MeV/c. 100,000 pictures were taken in the Argonne National Laboratory/MURA 30 inch hydrogen bubble chamber. These were selectively scanned for events in the two channels above, and in the channel $\pi^-p \rightarrow \pi^+\pi^-\pi^-n$. Selection criteria are established for identifying the reaction type and removing events with multiple neutrals. In $\pi^-p \rightarrow \pi^+\pi^-\pi^-p$, the dominant features are ρ^0(765 MeV) and N^{*2+}(1236 MeV) production. There is weak production of f^0(1260 MeV). It is found that the ρ's are virtually all produced forward, and the N^{*2+}(1236) is virtually always backward going in the c.m. system. In $\pi^-p \rightarrow \pi^+\pi^-\pi^-\pi^0p$, numerous enhancements are observed. The ρ^0 and ρ^-(765 MeV) are seen, as is the ω^0(783 MeV). N^{*2+}(1236) and N^{*+}(1236) occur; also, a π^0p enhancement is observed at a mass of 1585 MeV. In the $\pi^+\pi^-\pi^-$ mass spectrum, enhancements are seen at approximately 1550 MeV and 1310 MeV. It is felt that these may represent $A\bar{3}$ (1600 MeV) and $A\bar{2}$ (1300 MeV), though a comparison with other observations shows some anomalies. The most interesting aspects of this experiment are probably the $\pi^+\pi^-p$ and $\pi^+\pi^0p$ mass spectra. The $\pi^+\pi^-p$ spectrum shows enhancements at 1425 MeV and 2048 MeV. Similar enhancements have been reported by Fleury et al., and by Lamsa et al.; these are compared to the data. The $\pi^+\pi^0p$ spectrum shows a weak enhancement between 1800 and 2000 MeV. The $\pi^+\pi^-\pi^-p$ spectrum shows enhancement between 3000 and 3300 MeV; arguments are advanced that this is kinematic in nature. Additionally, an automatic spark chamber film reader, the GRUDI, is described. The design of an interface, and a set of machine language input/output routines, are discussed. (Diss. Abstr. Int., B)

3526 EXCHANGE AMPLITUDE CONTRIBUTIONS TO THE REACTION $K^- + p \rightarrow \Lambda + \pi^0$ NEAR 1 GeV/c. Louie, James. Berkeley, Calif., Univ. of California, 1968. 82p.

Thesis.

The reaction $K^- + p \rightarrow \Lambda + \pi^0$ is analyzed in terms of direct channel resonances and background exchange amplitudes, making fits to the experimental angular distributions, Λ polarizations, and $\Lambda\pi^0$ cross sections over the center-of-mass energy range 1700 to 1850 MeV. The primary aim of the study is to investigate the nature of the background terms, using K^* and nucleon crossed-channel exchanges, in the scattering amplitude required to fit the data. Previous J^P assignments are confirmed for $Y_1^*(1660)$, $Y_1^*(1770)$, and $Y_1^*(2030)$, and present branching ratio products $x_{\bar{K}N}x_{\Lambda\pi}$ for these three resonances. A mass and width for $Y_1^*(1770)$ are also determined. The data do not show much sensitivity to the presence of $Y_1^*(1910)$. The assumption of simple background exchange terms alone does not seem to be sufficient to fit the data. Modifications to these terms are made, producing reasonable fits. Effects due to the assumptions of the absorption model are also considered. (Diss. Abstr. Int., B)

3527 PION-PROTON CHARGE-EXCHANGE SCATTERING IN THE REGION 2.0 TO 2.6 BeV/c. Pifer, Albert Earl. Providence, Brown Univ., 1968. 104p.

Thesis.

The reaction: $\pi^- + p \rightarrow \pi^0 + n$, is analyzed at six momenta between 2.0 and 2.6 BeV/c with a very clean sample of about 600 events at each momentum. The total and differential cross sections for πp charge-exchange scattering are presented. The charge-exchange cross section at zero degrees is presented in the momentum region from 2.0 to 2.5 BeV/c for which no previous data exists. This is found to disagree with the results both of the Regge-pole and direct-channel interference model, and the dispersion calculation. The differential cross section in the forward hemisphere shows the exponential forward peak characteristic of charge-exchange at higher energies. The peak at $t = -1.0$ $(BeV/c)^2$ is also observed, but as the pion momentum is increased from 2.316 to 2.544 BeV/c it is observed to break into two peaks. This is thought to be associated with the $I = 3/2$ bump which was observed in πp total cross sections in this momentum region. The minimum found at a value of $t = -0.6$ $(BeV/c)^2$ at higher momenta has shifted to a value of -0.5 $(BeV/c)^2$. The forward peak is observed to turn over in this region. The differential cross section in the backward hemisphere has a peak in the backward direction and, as in π^+p scattering, a minimum near $u = -0.2$ $(BeV/c)^2$. The Legendre polynomial expansions of the differential cross sections required up to 13 coefficients at some momenta in order to obtain a rea-

sonable chi-square fit to the data. This implies that amplitudes with an l value of at least 6 have become significant. This could indicate the production of resonant states with very large spins. (Diss. Abstr. Int., B)

3528 INVESTIGATION OF $\pi^-p \rightarrow K_1^0K_1^0n$ AT 4 AND 5 GeV/c. Hoang, T. F. (Argonne National Lab., Ill.); Eartly, D. P.; Phelan, J. J.; (and others). Phys. Rev., 184: 1363-74(Aug. 25, 1969).

The reaction $\pi^-p \rightarrow K_1^0K_1^0n$ was investigated at 4 and 5 GeV/c in a spark-chamber experiment. The threshold enhancement in the s-wave $K_1^0K_1^0$ system is observed and can be fitted either by a complex scattering length or by a resonance form. An enhancement is also evident in the region of the f^0 and A_2^0 mesons, but no unambiguous interpretation of this effect can be given. (auth)

3529 FINAL STATES $K^-\pi^-\pi^+\pi^0p$ AND $K^-\pi^-\pi^+\pi^+n$ PRODUCED IN K^-p INTERACTIONS AT 4.6 AND 5.0 BeV/c. Juhala, R. E. (Ames Lab., Iowa); Leacock, R. A.; Rhode, J. I.; Kopelman, J. B.; Libby, L. Marshall; Urvater, E. Phys. Rev., 184: 1461-86 (Aug. 25, 1969).

The reactions $K^-p \rightarrow K^-\pi^-\pi^+\pi^0p$ and $K^-p \rightarrow K^-\pi^-\pi^+\pi^+n$ were studied at 4.6- and 5.0-BeV/c incident K^- momenta. Production cross sections for the $K^-\pi^-\pi^-\pi^+\pi^0p$ state are 0.76 ± 0.09 and 0.93 ± 0.12 mb, and for the $K^-\pi^-\pi^+\pi^+n$ state 0.42 ± 0.06 and 0.39 ± 0.07 mb, at 4.6 and 5.0 BeV/c, respectively. The combined sample for the $K^-\pi^-\pi^+\pi^0p$ state contains 1305 events. Resonance contributions include: $\bar{K}^{*0}(890)$, (19 ± 3)%; $K^{*-}(890)$, (7.2 ± 1.7)%; $\Delta^{++}(1236)$, (14.5 ± 2.5)%; $\Delta^+(1236)$, (8 ± 3)%; $\Delta^0(1236)$, <2%; $\omega^0(784)$, (14.5 ± 3)%; $\eta(548)$, (3.3 ± 1.3)%; a 1060-MeV 3π effect identified as the $A_1^0(1080)$, (10.5 ± 3)%; $A_2^0(1300)$, (3 ± 1.5)%; $\rho^+(760)$, (9 ± 2.5)%; $\rho^-(760)$, (5.5 ± 2)%; and a ~960-MeV narrow 3π enhancement, (2.5 ± 1)%. The A_1^0 is produced in this reaction in a way precluding contributions from the Deck effect. A spin-parity analysis for the A_1^0 provides good evidence that the spin-parity is in the sequence 0^-, 1^+, 2^-, ... Our results are consistent with the previously favored 1^+ assignment. 701 events were found in the combined sample for the $K^-\pi^-\pi^+\pi^+n$ final state. Contributions to this channel from accepted or suspected resonance states include: $\bar{K}^{*0}(890)$, (29 ± 4)%; $\Delta^-(1236)$, (17 ± 3)%; $\Delta^+(1236)$, (7 ± 2)%; and a narrow 960-MeV $\pi^+\pi^+\pi^-$ effect, (6 ± 2)%. Addition of $K^*\pi$ and $K\rho$ distributions from both final states corresponding to specific values of I_3 provides good evidence for production of $K_A(1320)$ and $K_N(1420)$. A similar treatment of $I_3 = 3/2$ $\Delta(1236)\pi$ and $N\rho(760)$ distributions indicates an effect near 1820 MeV. (auth)

3530 SINGLE-PION PRODUCTION IN π^-p INTERACTIONS AT 2.26 GeV/c. Reynolds, B. G.; Albright, J. R.; Bradley, R. H.; Brucker, E. B.; Harms, B. C.; Harrison, W. C.; Kimel, J. D.; Lannutti, J. E.; Sims, W. H.; Wieckowicz, R. P. (Florida State Univ., Tallahassee). Phys. Rev., 184: 1424-42(Aug. 25, 1969).

An analysis is presented of $\pi\pi N$ final states obtained from π^-p interactions at 2.26 GeV/c. Strong ρ production is present in both final states. In addition, significant nucleon isobar production is observed. The following cross sections were observed: $\sigma(\pi^-\pi^0p)$ = 3.77 ± 0.13 mb, $\sigma(\pi^-\pi^+n)$ = 5.67 ± 0.17 mb, $\sigma(\rho^-p)$ = 2.19 ± 0.09 mb, $\sigma(\Delta^+(1236)\pi^-)$ = 0.30 ± 0.10 mb, $\sigma(N^0(1650)\pi^0)$ = 0.49 ± 0.07 mb, $\sigma(\rho^0n)$ = 2.89 ± 0.11 mb, $\sigma(\Delta^-(1236)\pi^+)$ = 0.11 ± 0.06 mb, $\sigma(N^+ \times (1470)\pi^-)$ = 0.24 ± 0.06 mb, and $\sigma(N^+(1650)\pi^-)$ = 0.45 ± 0.05 mb. The spin-density matrix elements are determined for the ρ^0 by interpreting the ρ^0 asymmetry as an interference between the resonant P wave and a T = 0 S wave. A search for the ϵ^0 in the $\pi^+\pi^-n$ final state failed to yield a direct observation of this effect. (auth)

3531 SCATTERING OF K^- MESONS IN THE MOMENTUM RANGE 1.08 TO 1.37 GeV/c FROM A POLARIZED PROTON TARGET. Cox, C. R. (Rutherford Lab., Chilton, Eng.); Duke, P. J.; Heard, K. S.; Hill, R. E.; Holley, W. R.; Jones, D. P.; Shoemaker, F. C.; Thresher, J. J.; Warren, J. B.; Sleeman, J. C. Phys. Rev., 184: 1443-52(Aug. 25, 1969).

Asymmetry measurements were made in elastic K^--p scattering at eight beam momenta between 1.08 and 1.37 GeV/c, and covering a range in cos θ between 0.78 and −0.95, where θ is the scattering angle in the c.m. system. Measurements were made using a 17-m-long unseparated beam of negative particles, kaons being selected by a differential liquid Cherenkov counter. The method employed was to scatter off a polarized proton target and detect the scattered particles with arrays of plastic scintillation counters. Information was processed by a fast logic system incorporating tunnel diodes, which was linked directly to a PDP-5 computer. The latter performed some preliminary analysis, with particular reference to background measurement. The results of the measurements are tabulated and compared with polarization predictions derived from fits to differential cross-section experiments. (auth)

3532 SCATTERING OF π^- MESONS IN THE MOMENTUM RANGE 0.643 TO 2.14 GeV/c FROM A POLARIZED PROTON TARGET. Cox, C. R. (Rutherford Lab., Chilton, Eng.); Duke, P. J.; Heard, K. S.; Hill, R. E.; Holley, W. R.; Jones, D. P.; Shoemaker, F. C.; Thresher, J. J.; Warren, J. B.; Sleeman, J. C. Phys. Rev., 184: 1453-61(Aug. 25, 1969).

The asymmetry in the scattering of π^- mesons by polarized protons was measured at 50 different momenta from 0.643 to 2.14 GeV/c. Results were obtained at values of cos θ ranging from approximately +0.9 to −0.95 in the c.m. system at each incident pion momentum. The pion beam was incident on a 7.6-cm-long crystal assembly of lanthanum magnesium nitrate, in which the hydrogen in the water of crystallization was polarized by the "solid effect." The total momentum spread of the beam was 10% (full width at half-height) and data were collected simultaneously in 4 momentum channels, each with 2½% full width at half-height. A gas Cherenkov counter was used to reject incoming electrons. Scattered particles were detected in scintillation counter arrays placed within the 10-cm gap of the polarized target magnet. Encoded information from each array was stored in the memory of a PDP-5 computer connected on-line to a fast electronic logic network. The computer was programmed to classify the events according to momentum and scattering angle and subdivide them into coplanar and noncoplanar categories. The latter provided a measure of the background. The results are expressed in the form of an expansion in terms of first associated Legendre polynomial series and compared with the predictions of recent phase-shift solutions. It is concluded that although these analyses give satisfactory predictions of the general features of the results, no one solution gives complete agreement with the data above about 1.0 GeV/c. (auth)

3533 REACTION $\pi^-p \rightarrow \pi^-\pi^0p$ AT 8 GeV/c. Barish, S. J. (Univ. of Pennsylvania, Philadelphia); Selove, W.; Biswas, N. N.; Cason, N. M.; Johnson, P. B.; Kenney, V. P.; Poirier, J. A.; Shephard, W. D.; Yuta, H. Phys. Rev., 184: 1375-80(Aug. 25, 1969).

A sample of 1147 events of the type $\pi^-p \rightarrow \pi^-\pi^0p$ was obtained from the measurement of 30 400 two-prong events in an exposure of the Brookhaven 80-in. hydrogen bubble chamber to an 8-GeV/c π^- beam. In the $\pi^-\pi^0$ system, the ρ^- and g^- mesons are observed; neither is strongly associated with isobar production. The presence of appreciable ω^0 exchange in $\pi^-p \rightarrow \rho^-p$ is suggested by the shape of the Δ^2 distribution in this reaction and by the ratio of the production cross sections $\sigma(\pi^- p \rightarrow \rho^0n)/\sigma(\pi^-p \rightarrow \rho^-p)$ at 8 GeV/c. (auth)

3534 S-WAVE $\pi\pi$-SCATTERING FROM THE REACTION $\pi^-p \rightarrow n\pi^0\pi^0$ AT 1.77 GeV/c. Deinet, W.; Menzione, A.; Mueller, H.; Staudenmaier, H. M. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Phys. Lett., 30B: 359-63(Oct. 27, 1969).

Differential cross sections for the reaction $\pi^-p \rightarrow n\pi^0\pi^0$ are given. Chew Low extrapolation to the pion pole are carried out. The resulting cross section for $\pi^-\pi^+ \rightarrow \pi^0\pi^0$ stays near its unitarity limit for I = 0 s-wave scattering over the mass region 0.36 to 0.80 GeV^2 indicating a very broad s-wave $\pi\pi$ resonance. The up-down solution of the s-wave phase shifts is the only one consistent with the data. (auth)

3535 ANGULAR CORRELATIONS BETWEEN π^0 MESONS PRODUCED IN π^-−Xe INTERACTIONS AT 9 GeV/c π^- INCOMING MOMENTUM. Eskreys, K. (Academy of Mining and Metallurgy, Krakow). Acta Phys. Pol., 36: 237-40(Aug. 1969).

Strong angular correlations between neutral pions were found in the 9 GeV/c π^- Xe interactions observed in the xenon bubble chamber. Angular correlations of the same kind have been previously reported for charged pions produced in $\bar{p}$−p and π^+−p interactions. (auth)

3536 CROSS SECTIONS FOR MULTIPION PRODUCTION IN π−p AND p−p COLLISIONS NEAR THRESHOLDS. Bartke, J. (Inst. of Nuclear Research, Krakow); Sosnowski, R. Acta Phys. Pol., 36: 277-9(Aug. 1969).

The cross sections for the pion production in high-energy π−p and p−p collisions were compared to the phase space predictions. It was found that a correct description is obtained for the near-threshold behavior of the cross sections. The relation between the π−p and p−p cross sections proposed by Satz on the basis of the quark model seems as well to have a simple explanation. (auth)

3537 THE RESONANCE $Y_0^*(1327) \rightarrow \Lambda + \gamma$. Bogachev, N. P.; Budagov, Yu. A.; Vinogradov, V. B.; (and others). (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 10: 105-8(Aug. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 10: 168-72(Aug. 20, 1969).

A propane bubble chamber was exposed to a pion beam of momentum 5.1 GeV/c. The obtained effective-mass spectrum of the $\Lambda^0 + \gamma$ combinations for $\pi^- + p$ events has two maxima. The first corresponds to the creation of a neutral sigma hyperon, and the second is in the mass region from 1290 to 1440 MeV. The second maximum also appears in the meson (π^-) reaction with carbon events. This maximum is determined to be the $\Lambda(1327)$ resonance, and its production cross section is given. (J.F.P.)

3538 ANALYSIS OF THE REACTION $\pi^+d \to d\pi^+\pi^+\pi^-$ AT 5 GeV/c INTERPRETATION WITH A REGGEISED π-EXCHANGE MODEL. Vanderhaghen, R. (Ecole Polytechnique, Paris); De Rosny; Armenise, N.; Ghidini, B.; Romano, A.; Forino, A.; Goldberg, M. Nucl. Phys., B13: 329-50(1969).

With a sample of 1304 events that fit the reaction $\pi^+d \to d\pi^+\pi^+\pi^-$ at 5 GeV/c, a total cross section of 342 ± 25 μb was found; and the final state contained 31% $d^*\rho^0$, 6% d^*f^0, 14% $d^*(\pi\pi)_{IZ=2}$ and 43% of $d\pi\rho$. The production cross sections and differential distributions were interpreted in terms of a Reggeized π-exchange mechanism and it is shown that for the $\rho\pi$ system the model predicts distributions indistinguishable from the ones obtained from the $A_1(1^+)$ hypothesis. The experimental widths of the ρ^0 and f^0 are smaller than usually observed in strong interaction experiments. (auth)

3539 LOW-ENERGY K^- MESON ELASTIC SCATTERING FROM HYDROGEN. Thomas, G. P.; Jain, P. L. (State Univ. of New York, Buffalo). Nucl. Phys., B13: 385-400(1969).

A total of 45 K^-p low-energy elastic scattering between 0 to 250 MeV/c was found by following 276.4 m of K^- meson tracks backward from their capture points in nuclear emulsion. The total scattering cross section is plotted as a function of kaon momentum and is compared to previous data. Theoretical values calculated for the elastic scattering cross sections in the low-energy range 30 to 100 MeV/c are seen to be sensitive to the values of the scattering length parameters used in the S-wave zero-effective range theory which is used here to fit the data in this range. The best fit to the data is given by the scattering length values as given by Cho, i.e., $a_0 = -1.21 + 0.56i$, $a_1 = -0.19 + 44i$ for the isospin T = 0 and T = 1 channels, respectively. Further evidence for S-wave interaction is discussed through the angular distribution in the center-of-mass system for the elastic events. (auth)

3540 DECAY ANALYSIS OF THE LOW-MASS $\pi\pi$ ENHANCEMENT INTO K^0_{890} AND π-π SYSTEMS. Alexander, Gideon; Firestone, Alexander; Goldhaber, Gerson; Lissauer, David (Univ. of California, Berkeley). Nucl. Phys., B13: 503-10(1969).

The low-mass $K\pi\pi$ enhancement is studied in $K^+p \to K^+\pi^+\pi^-p$ and $K^+p \to K^0\pi^+\pi^0p$ interactions at 9 GeV/c. This enhancement consists of two peaks of mass and width M = 1260 ± 10 MeV, Γ = 40 ± 10 MeV and M = 1380 ± 20 MeV, Γ = 120 ± 20 MeV. The main decay modes are $K^0_{890}\pi$ and ρK, which interfere strongly. A consistent description of the data requires either an additional decay mode into K^+ plus an I = 0 s-wave π-π system (ϵ^0_{720}) or a large interference effect between two components of the Q, or both. (auth)

3541 A COMPARISON OF $K^-p \to \pi^-Y_1^{*+}(1385)$ AND $\pi^+p \to K^+Y_1^{*+}(1385)$ AT 5.5 GeV/c. Mott, J. (Indiana Univ., Bloomington) Nucl. Phys., B13: 565-70(1969).

At 5.5 GeV/c incident momentum the rate for $K^-p \to \pi^-Y_1^{*+}(1385)$ exceeds the rate for $\pi^+p \to K^+Y_1^{*+}(1385)$ by a factor of ~ 1.6. This factor is qualitatively predicted by a one-meson exchange model when absorption is taken into account. (auth)

3542 GENERAL CHARACTERISTICS OF PARTICLE PRODUCTION IN 16 GeV/c π^-p INTERACTIONS. Honecker, R. (Technische Hochschule, Aachen); Junkmann, B.; Schulte, R.; (and others). Nucl. Phys., B13: 571-86(1969).

Partial cross sections are presented for the various topologies and the various reaction channels in 16 GeV/c π^-p interactions. Their energy dependence is discussed. The distributions of events as a function of the squared four-momentum transfer are presented, as well as the transverse and c.m. longitudinal momenta distributions. The predictions of the Chan, Łoskiewicz and Allison model describe some of the gross features of these experimental results, but important disagreements are found, mostly in the low multiplicity channels. (auth)

3543 THE K^+p INTERACTION FROM 864 TO 1585 MeV/c: CROSS SECTIONS AND MASS DISTRIBUTIONS. Bland, Roger W.; Bowler, Michael G.; Brown, John L.; Kadyk, John A.; Goldhaber, Gerson; Goldhaber, Sulamith; Seeger, Victor H.; Trilling, George H. (Univ. of California, Berkeley). Nucl. Phys., B13: 595-621 (1969).

Cross sections are presented for five momenta from 864 to 1585 MeV/c, for stable final states and for resonance production, and an analysis is made of the $KN\pi$ Dalitz plots including the effects of $K^*(891) - \Delta(1236)$ interference. Strong interference is seen at all momenta where the K^* is present, with the relative phase of the K^*N and $K\Delta$ amplitudes remaining constant as a function of momentum. The cross-section results are combined with those from other experiments to study the momentum dependence of the partial cross sections in the region of the 1250 MeV/c peak in the total cross section: it is found that the total cross-section curve can be represented as the sum of partial cross-section curves, each one smooth and without a peak corresponding to that in the total cross section. Thus this structure is not due to structure in any single partial cross section, but rather to the sharp rises of the single- and double-pion-production channels at widely separated thresholds. This interpretation is at variance with a conventional resonance interpretation of the observed structure in the total cross section. (auth)

3544 INVESTIGATION OF PENETRATING COMPONENT OF HIGH-ENERGY COSMIC RAYS ON MOUNTAIN LEVEL. Erlykin, A. D.; Kulichenko, A. K.; Nikol'skii, S. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 10: 592-604(Sep 1969). (In Russian).

Investigating contents, angular distribution and energy spectrum of the penetrating component in the energy range 10^{11} to 10^{13} eV, obtained by means of the underground ionization calorimeter of TSVNS of the Physical Institute, one shows that: at energies $E \gtrsim 10^{11}$ eV the penetrating component not too deep under ground consists essentially of muons only; the differential energy spectrum of muons at $E_\mu \approx 2.10^{11} - 10^{13}$ eV may be described by the law $(\partial F/\partial E_\mu)(E_\mu) = A[(E_\mu/10^{11})^{-(2.6\pm0.1)}/E_\mu + E_{cr}]$ where E_{cr} = 116 GeV, $A = 5.4 \cdot 10^{-5}$ cm^{-2} sec^{-1} sterad^{-1}; the principal source of muons with $E_\mu \approx 10^{12}$ eV is the pion decay. However, it is possible that there is a mechanism of generation of the muons with $E_\mu \gtrsim 10^{12}$ eV that is more effective than the $\pi-\mu$ decay, provides more isotropic distribution, and whose contribution increases with the muon energy. Possible sources of muons with even more energies, $E_\mu \gtrsim 10^{13}$ eV, are discussed. (auth)

3545 PRODUCTION OF RESONANCES IN REACTIONS $\pi^-p \to \pi^+\pi^-\Lambda^0K^0$ AND $\pi^-p \to K^+\pi^-\Lambda^0\pi^0$ AT 4.0 GeV/c. Kuznetsov, A. A.; Melnikova, N. N.; Ryltseva, T. V.; Chadraa, B.; Balint, V.; Mikhul, A.; Mumuyanu, D.; Ponta, T.; Felea, S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 10: 577-84 (Sept. 1969). (In Russian).

Strange particle production in π^-p interactions at 4.0 GeV/c is investigated. Data on the resonance production cross sections in processes $\pi^-p \to \pi^+\pi^-\Lambda^0K^0$ and $\pi^-p \to K^+\pi^-\Lambda^0\pi^0$ are presented. The results are compared with other experiments at near energies. An indication is obtained that the nucleon isobar N^*_η (1710) decaying into the ΛK state is produced in these processes. (auth)

3546 REACTION $\pi^-p \to \pi^+\pi^-n$ AT ENERGY OF 400 MeV AND MAIN PRODUCTION PROPERTIES OF THE $N^*(^3/_2,^3/_2)$-ISOBAR STATE. Komar, A. P.; Gasilova, N. C.; Lepekhin, F. G.; Makarov, M. M.; Sarentsev, V. V.; Tkach, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 10: 569-76 (Sept. 1969). (In Russian).

Energy and angular characteristics of the reaction $\pi^-p \to \pi^+\pi^-n$ at an energy of 400 MeV are studied. The $N^*(^3/_2,^3/_2)$-isobar production amplitude as well as the creation states are determined. It is shown that the isobar is produced in P and in S states with the recoiled pion. Contributions from the interference with various partial waves are estimated qualitatively. (auth)

3547 CHARGED-PION LIFETIME AND A LIMIT ON A FUNDAMENTAL LENGTH. Greenberg, Arthur J. (Univ. of California, Berkeley); Ayres, David S.; Cormack, Allan M.; Kenney, Robert W.; Caldwell, David O.; Elings, Virgil B.; Hesse, William P.; Morrison, Rollin J. Phys. Rev. Lett., 23: 1267-70(Nov. 24, 1969).

The lifetime of the charged pion was determined in flight. The agreement of the result, 26.02 ± 0.04 nsec, with experiments of comparable precision made with pions at rest provides the most precise verification of time dilation. In the model of Lundberg and Rédei this comparison sets an upper limit on a fundamental length of 3×10^{-18} cm. Using the measurements of velocity and momentum for both π^+ and π^-, $m(\pi^+)/m(\pi^-) = 1.0002 \pm 0.0005$ is also obtained. (auth)

3548 $K^-p \to \Sigma^+\pi^+(\pi^0)$ FROM 594 TO 820 MeV/c. Berley, D.; Hart, E.; Rahm, D.; Willis, W.; Yamamoto, S. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 30B: 430-3(Nov. 10, 1969).

Data on K^-p interactions yielding charged sigma hyperons are presented. The cross sections and angular distributions are explained by $\Lambda(1670)$ and $\Lambda(1690)$ resonances. The $\Sigma(1660)$ found in production experiments shows little or no coupling to the $\bar{K}N$ system. (auth)

3549 DECAY ASYMMETRY OF THE $K^-\pi^+$ SYSTEM IN K^- NUCLEON INTERACTIONS AT 3 GeV/c. Goldberg, J.

(Ecole Polytechnique, Paris); Huffer, E.; Laloum, M.; (and others). Phys. Lett., 30B: 434-6(Nov. 10, 1969).

The decay asymmetry of the $K^-\pi^+$ system was measured in two reactions and found to be equal to that observed for $K^+\pi^-$ systems, in agreement with its interpretation as an S wave effect in $K\pi$ scattering. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 3490, 3728, and 3760.

3550 (COO-1764-39) THEORETICAL AND HIGH ENERGY PHYSICS PROGRAMS. Progress Report, September 1, 1968-August 31, 1969. (Minnesota Univ., Minneapolis. School of Physics). Contract AT(11-1)-1764. 54p. Dep. CFSTI.

Research at the University of Minnesota on theoretical nuclear physics and theoretical and experimental elementary particle physics from September, 1968, to August, 1969 is summarized. A list of publications is also included. (J.F.P.)

3551 GRAVITATIONAL INTERACTION OF ELEMENTARY PARTICLES. Barker, Bruce Michael. Detroit, Wayne State Univ., 1965. 75p.

Thesis.

Using Gupta's quantum theory of gravitation, the exact relativistic gravitational interaction of particles of various spins is calculated in the center-of-mass system to the second order in the coupling constant. From the exact calculations, which exhibit full velocity and spin dependence, the nonrelativistic, extreme-relativistic, large-mass, and large-distance approximations were obtained. From the large-distance approximation, which leads to the same result in all cases, a principle of equivalence is formulated. The gravitational potential is also obtained for identical particles and their antiparticles, and the particle-particle as well as the particle-antiparticle interactions are found to be attractive, which shows that contrary to some speculations matter and antimatter attract each other. Finally, the gravitational interaction between photons and particles of spin 0 and $\frac{1}{2}$ is investigated, and the effect of photon polarization on its gravitational interaction is analyzed. (Diss. Abstr. Int., B)

3552 OBSERVABLES FOR MASSIVE RELATIVISTIC PARTICLES OF ARBITRARY SPIN. de Azcarraga, J. A.; Oliver, L. (Instituto de Fisica Teorica, Barcelona). J. Math. Phys. (N. Y.), 10: 1869-74(Oct. 1969).

The expressions for the dynamical operators corresponding to a Bargmann-Wigner particle of mass κ and arbitrary spin s are given, making use of the Foldy-Wouthuysen and Chakrabarti transformations for the Bargmann-Wigner equations given by Pursey, and Azcárraga and Boya, respectively. The operators selecting the positive and negative energy states are also given in the two representations. The operators for arbitrary spin are studied and a condition for an operator to be a constant of motion is given. Finally, the Newton-Wigner position operator and those obtained in the Foldy-Wouthuysen and Chakrabarti generalized representations are compared. (auth)

3553 EXTERIOR THREE-PARTICLE WAVE FUNCTION. Noyes, H. Pierre (Stanford Univ., Calif.). Phys. Rev. Lett., 23: 1201-5(Nov. 17, 1969).

It is shown that the wave function for three particles interior to the finite volume where all force ranges overlap completely determines the exterior wave function via the solution of a one-variable integral equation with a compact kernel. A unitary parametrization of the interior wave function therefore would supply the equivalent of a phase-shift analysis for three-particle final states, including the exact description of overlapping resonances throughout the Dalitz plot. (auth)

3554 SOME REMARKS ON CURRENT-FIELD COMMUTATORS. Genz, H.; Katz, J. (Univ., Hamburg). Nuovo Cim., 64A: 291-304(Nov. 21, 1969).

Implications of the Jacobi identity and Lorentz invariance in the study of equal-time current-field and current-current commutators are discussed. It is shown that these commutators are related by means of the Jacobi identity. Assuming Lorentz invariance it is then proven that equal-time commutators between space components of conserved currents and spinor fields do not have Schwinger terms, provided the same holds for their time components. Moreover, the commutators between the time derivatives of space components of these currents and the field can only have first-order Schwinger terms. These results are also obtained for nonconserved currents whose divergences commute at equal times with the field. In general, equal-time commutators between divergences of currents (or their time derivatives) and fields cannot have first (second) order Schwinger terms. Connections with usual quark and field algebra relations are discussed. (auth)

3555 KINEMATICS OF PARTICLE INTERACTIONS. Synge, J. L. (Dublin Inst. for Advanced Studies). Proc. Roy. Soc. (London), Ser. A, 312: 467-72(Sept. 30, 1969).

For a 2-particle interaction a new canonical frame of reference is defined, namely, one making diagonal the matrix of quadratic moments of the four 4-momenta of the incoming and outgoing particles. When constraint coordinates are used, based on the above canonical frame, on the mass-shell, and on the conservation of momentum and energy, it is found that the Jacobian of the transformation from the natural coordinates to the constraint coordinates has an interesting simple form. In fact, to within a trivial numerical factor, it is a simple symmetric function of the eigenvalues of the 4×4 matrix formed by the scalar products of the 4-momenta. (auth)

3556 EQUAL-TIME COMMUTATORS AND THE ENERGY-MOMENTUM TENSOR. Genz, H.; Katz, J. (Univ., Hamburg). Nucl. Phys., B13: 401-14(1969).

Starting from a generalization to spinor fields $\bar{\psi}$ of the equal-time commutator between the time components of the vector and axial vector currents V_0^i and A_0^i and the energy density part of the canonical energy-momentum tensor the current-field commutators are investigated. Assuming that the equal-time commutators $[V_0^i(X,x_0),\bar{\psi}(Y,x_0)]$ and $[A_0^i(X,x_0),\bar{\psi}(Y,x_0)]$ are proportional to the field itself and have no Schwinger terms, the absence of Schwinger terms in the equal-time commutators $[V_k^i(X,x_0),\bar{\psi}(Y,x_0)]$, $[A_k^i(X,x_0),\psi(Y,x_0)]$, and $[(\partial/\partial x_0)A_\mu^i(X,x_0),\bar{\psi}(Y,x_0)]$ is shown. Thus $[(\partial/\partial x_0)V_0^i(X,x_0),\bar{\psi}(Y,x_0)]$ only contains a first-order Schwinger term and $[(\partial/\partial x_0)A_0^i(X,x_0),\bar{\psi}(Y,x_0)]$ only contains a non-Schwinger term and a first-order Schwinger term. In addition it is shown that quark model results for $[V_\mu^i(X,x_0),\bar{\psi}(Y,x_0)]$ and $[A_\mu^i(X,x_0),\bar{\psi}(Y,x_0)]$ follow from assuming the transformation properties of these equal-time commutators to be identical to those of $\bar{\psi}\gamma_\mu\gamma_4$ and $\bar{\psi}\gamma_\mu\gamma_4\gamma_5$ respectively. The possible deviations from the quark model are found to be given by the equal-time commutators between the spinor current $f_m(x)$ and the time component of the vector and axial vector currents. Some implications for quark model and algebra of fields current commutators are discussed. Finally a comment is made on symmetry breaking. It is shown that if the non-Schwinger part of the equal-time commutator between the time components of conserved currents is the time component of a current, then this current is conserved. Necessary and sufficient conditions are given in order for the non-Schwinger part of the equal-time commutators between the time components of conserved and non-conserved currents or between the time components of non-conserved currents to be the time component of a conserved or non-conserved current. (auth)

3557 A NOTE ON THE DERIVATION OF CURRENTS FROM THE LAGRANGIAN. Dass, T. (Indian Inst. of Tech., Kanpur). Nuovo Cim., Lett., 2: 584-6(Oct. 21, 1969).

The usual prescriptions for calculating the currents $j_\mu^{(r)}(x)$ [r = 1, . . ., n] of an n-parametric continuous group and their divergences from the Lagrangian are shown to be inconsistent with the equations of motion of the gauge field. The source of the inconsistency arises when variations of field quantities involve derivatives of the group parameters. Modifications to eliminate the inconsistency are illustrated. (C.E.S.)

3558 HNZ CONSTRUCTION FOR COMPOSITE PARTICLES. Nishijima, Kazuhiko; Sato, Hikaru (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 692-7(Sept. 1969).

The nature of the HNZ construction for composite particles is investigated. It is concluded that the limiting value of the denominator function in the HNZ construction is finite for a composite particle in contrast to the case of an elementary particle. (auth)

Electromagnetic

Refer also to abstracts 3208, 3486, and 3741.

3559 SINGLE-PION PHOTOPRODUCTION FROM HYDROGEN. Taylor, Merlin Gene. Providence, Brown Univ., 1968. 102p.

Thesis.

The single-pion photoproduction reactions, $\gamma + p \rightarrow \pi^+ + n$ and $\gamma + p \rightarrow p + \pi^0$, were analyzed in the photon momentum region from threshold to approximately 6 BeV/c. The interactions were produced in a 12 in. liquid-hydrogen bubble chamber exposed to a

hardened bremsstrahlung beam from the Cambridge Electron Accelerator. The bubble chamber was located in a 13 Kg magnetic field so that the particle momentum could be determined from track curvature. The identification of the events was accomplished primarily by comparison of the observed track bubble density with that expected for a particle of a given momentum. Differential and total cross sections at the lower photon momenta ($P_\gamma < 0.8$ BeV/c) are seen to agree with the results of previous counter experiments. In the region of the third pion–nucleon resonance (0.8 BeV/c < P_γ < 1.2 BeV/c) the $\gamma + p \rightarrow p + \pi^0$ total cross section is observed to have an average value of (34 ± 6) μb. This is appreciably above the value observed at the maximum photon momentum of the counter experiments ($P_\gamma \approx 0.85$ BeV/c). The ratio of the $\gamma + p \rightarrow \pi^+ + n$ to $\gamma + p \rightarrow p + \pi^0$ total cross sections in the region of the third resonance (0.8 BeV/c < P_γ < 1.2 BeV/c) was found to lie between 0.6 and 1.3. This ratio is not consistent with the value of 2 expected for isotopic spin $T = \frac{1}{2}$ resonances. It is shown that the results of the experiment are consistent with the presence of a $T = \frac{3}{2}$ resonance in the form of the S_{31} wave interaction observed in phase-shift analyses of pion–nucleon scattering data. (Diss. Abstr. Int., B)

3560 ELECTRIC DIPOLE MOMENT OF THE NEUTRON: EXPECTED ORDER OF MAGNITUDE. Barton, G.; White, E. D. (Univ. of Sussex, Brighton, Eng.). Phys. Rev., 184: 1660-2 (Aug. 25, 1969).

Sideways dispersion relations yield a theoretically well-defensible "lower limit" on the expected order of magnitude of the neutron electric dipole moment. If T violation is due to the weak interactions, then 10^{-24} e cm appears as a reasonable expectation, and 10^{-23} e cm the most one can hope for. If T violation is due to the electromagnetic interactions of hadrons, one cannot safely expect more than 10^{-23} e cm, although optimistic guesses can easily yield 6×10^{-22} e cm or more. (auth)

3561 LOW-ENERGY THEOREM FOR COMPTON SCATTERING. Saito, S. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 184: 1894-1902(Aug. 25, 1969).

The low-energy theorem for Compton scattering on arbitrary spin targets is derived. Knowledge of the Born term of the amplitude, which is calculated explicitly, enables Singh's lemma to be proved, which allows the threshold value of the amplitude to be calculated from the gauge condition. Every multipole moment of the target is written down explicitly in terms of the low-energy limit of the amplitude. Up to linear order in photon energy ω, this theorem becomes a generalization to arbitrary spin of the theorem derived by Low and by Gell-Mann and Goldberger. To describe the spin-nonflip amplitude up to order ω^2, two structure-dependent parameters are needed in addition to the charge and magnetic moment. (auth)

3562 ρ DOMINANCE AND ELECTROMAGNETIC FORM FACTORS. Curry, P.; Moffat, J. W. (Univ. of Toronto). Phys. Rev., 184: 1885-7(Aug. 25, 1969).

A finite-width expression for the pion form factor with the correct analytic properties is equated to the nucleon isovector form factor $F_1^V(t)$, and the nucleon data are used to determine the parameters. The predicted $|F_\pi(t)|^2$ is found to agree reasonably well with the colliding-beam data, and the predicted branching ratio $\Gamma(\rho \rightarrow e^+e^-)/\Gamma(\rho \rightarrow \pi^+\pi^-)$ and ρ-γ coupling constant are consistent with the Orsay results. The width $\Gamma_\rho(\rho \rightarrow \pi^+\pi^-) = 112$ MeV, and $m_\rho = 765$ MeV. The nucleon and pion mean-charge radii are found to be $\langle r_N \rangle = 0.86$ F and $\langle r_\pi \rangle = 0.70$ F. (auth)

3563 LOW-ENERGY THEOREMS ON RADIATIVE CORRECTIONS. Cheng, T. P. (Rockefeller Univ., New York). Phys. Rev., 184: 1805-15(Aug. 25, 1969).

A general method is presented for evaluating, in a model-independent way, the soft-virtual-photon radiative corrections to an arbitrary hadronic process. It is shown that all the results concerning infrared divergences obtained within the theory of quantum electrodynamics of the electron-photon system are, in fact, exact in strong interactions. The problem of radiative corrections to low-energy theorems is the primary concern of this investigation. The threshold contributions of intermediate soft-photon states are nonanalytic in the photon frequency ω. While the procedure is general enough to permit, in principle, the calculation of the leading terms (as $\omega \rightarrow 0$) of these radiative corrections to all orders in e, only the leading e^2 radiative corrections are computed explicitly: They are of the order $\ln\omega$ for the bremsstrahlung (as first noted by Soloviev) and of the order $\omega \ln\omega$ for pion photoproduction. Accordingly, in the presence of radiative corrections, there are no longer any low-energy theorems for the $O(\omega^0)$ bremsstrahlung and $O(\omega)$ pion photoproduction amplitudes. The e^4 Compton amplitude $O(\omega^2 \ln\omega)$ is computed and shown to be independent of the target spin. (auth)

3564 SIGN OF THE $\pi^0 \rightarrow \gamma\gamma$ DECAY AMPLITUDE. Gilman, Frederick J. (Stanford Univ., Calif.). Phys. Rev., 184: 1964-5 (Aug. 25, 1969).

The experimentally observed constructive interference between the amplitude for the Primakoff effect and the other amplitudes involved in π^0 photoproduction is interpreted as showing that the $\pi^0 \rightarrow \gamma\gamma$ decay amplitude and $g_{\pi NN}$ have opposite signs. The experimental $\pi^0 \rightarrow \gamma\gamma$ amplitude thus agrees in sign and approximately in magnitude with the result of computing the triangle graph in perturbation theory with a single elementary proton going around the fermion loop. (auth)

3565 REGGE-POLE MODEL FOR INVARIANT FUNCTIONS. III. PHOTOPRODUCTION FOR UNPOLARIZED AND LINEARLY POLARIZED PHOTONS. Muetter, K. H.; Traenkle, E. (Freie Univ., Berlin). Phys. Rev., 184: 1555-63(Aug. 25, 1969).

It was shown in Paper II that the three Regge-type poles π, B, and C reproduce the $pn \rightarrow np$ and $p\bar{p} \rightarrow n\bar{n}$ data. The same trajectories are used in this paper to give a description of the π^+ photoproduction near the forward direction ($t \approx 0$). For larger values of $|t|$, however, inclusion of the ρ and R trajectories become necessary. (auth)

3566 PHYSICAL THEORY: PROCESS OF PRODUCTION OF PARTICLES OF THE TYPE $ee \rightarrow ee A\bar{A}$. Arteaga-Romero, Napoleon, Jaccharini, Antoine; Kessler, Paul (College de France, Paris). Comp. Rend., Ser. B, 269: 153-6(July 28, 1969). (In French).

Numerical calculations were carried out on processes of the type $ee \rightarrow ee A\bar{A}$ (A being a muon, pion, or kaon), considering the kinematical conditions which make preponderant the contribution of two-photon exchange space diagrams and applying a double Williams–Weizsäcker approximation to these diagrams. (tr-auth)

3567 FORM FACTORS AND IMPACT FACTORS IN HIGH-ENERGY SCATTERING. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev., 184: 1868-72 (Aug. 25, 1969).

The general properties of the impact factor are studied. In particular, the fourth-order impact factor for the electron is shown to exist and is explicitly worked out. This implies that the sum of the corresponding sixth-order amplitudes for processes like electron–electron scattering satisfies the impact-factor representation. It is also found that, in both the second and the fourth order, the impact factor is proportional to the electromagnetic form factor. An interesting relation between the impact factor and the form factor is then shown to hold generally. These arguments are next extended to scalar mesons and the same conclusions are reached. Considerations on the impact factor in higher orders are also made. (auth)

3568 TWO-PHOTON EXCHANGE IN ELECTRON–PROTON SCATTERING. Greenhut, Gary K. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 184: 1860-7(Aug. 25, 1969).

An investigation is made of the two-photon exchange contribution to e-p scattering. The contribution is calculated in second Born approximation using potentials representing the charge and magnetic moment distributions of the proton. A fit to proton Compton scattering data is made and used to calculate the resonance contribution to e-p scattering. At high energies, the resonant and nonresonant contributions to the two-photon exchange effect tend to cancel one another. (auth)

3569 ELECTROMAGNETIC PROPERTIES OF HADRONS IN A COVARIANT QUARK MODEL. Gudehus, Timm (Univ. of Miami, Coral Gables). Phys. Rev., 184: 1788-92(Aug. 25, 1969).

Among others, formulas for the $\omega\pi\gamma$, the $\rho\pi\gamma$, and the $N^*N\gamma$ transition moments, and relations between the electric, magnetic, and transition form factors of the $\frac{1}{2}^+$ baryons and the $\frac{3}{2}^+$ baryon resonances, are derived within the framework of a covariant quark model. (auth)

3570 RELATIVISTIC MODEL FOR ELECTROPRODUCTION OF NUCLEON RESONANCES. II. Pritchett, P. L.; Walecka, J. D.; Zucker, P. A. (Stanford Univ., Calif.). Contract AFOSR F44620-68-C-0075. Phys. Rev., 184: 1825-48(Aug. 25, 1969).

A relativistic gauge-invariant model for electron excitation of nucleon resonances introduced previously is developed and extended. A coupled-channel calculation is carried out retaining the $|\pi N\rangle$ and $|\pi N^*(1236)\rangle$ channels and assuming that one eigenphase shift is resonant. The eigenphase shift is determined from phase-shift analyses of π-N scattering, and the mixing angle from the decay widths of the resonance. The model chosen for the resonant amplitude is a product of two factors: a generalized Feynman amplitude for excitation of the resonant channel, and a final-state enhancement factor which is related to an integral over the eigenphase shift. The model is shown to be an approx-

imate solution to the coupled-channel Omnès equations. Further extensions consist of including N*(1236) exchange in the excitation amplitude for the $|\pi N\rangle$ channel and of investigating the effect of different fits to G_{E_n} on the inelastic form factors. The predictions of the theory are compared with all existing data—in particular, with the recent results from SLAC. (auth)

3571 COMMENTS ON THE K^+–K^0 ELECTROMAGNETIC MASS SHIFT. Chaudhuri, R. N.; Vaishya, J. S. (Univ. of Delhi). Phys. Rev., 184: 1958-61(Aug. 25, 1969).

The K^+-K^0 electromagnetic mass difference is analyzed using (i) hard-kaon current algebra of chiral SU(3) × SU(3) [with a symmetry-breaking term which transforms as $(3,3^*) \oplus (3^*,3)$] and (ii) dispersion theory in conjunction with soft-kaon current algebra. The results differ in that the K* intermediate state appears in the latter approach but not in the former. Its contribution is analyzed in detail and shown to have the correct sign. From the analysis it is concluded that the mass shift cannot be of the correct sign and magnitude for a reasonable value of the cutoff unless the contribution of the σ term is large. Comment is also made on Riazuddin and Sarker's analysis for the VVP vertex which appears in our calculations. (auth)

3572 π^0 PHOTOPRODUCTION WITHOUT A B TRAJECTORY OR CUTS. Bajpai, R. P. (Univ. of Glasgow); Donnachie, A. Phys. Lett., 30B: 344-6(Oct. 27, 1969).

A model for π^0 photoproduction is proposed in terms of ω and ρ Regge trajectories with different slopes. The model not only explains all the high-energy differential cross section data, but also predicts the correct asymmetry in cross sections with polarized photons. (auth)

3573 ON THE ARRIVAL TIME DISTRIBUTION OF THE MUONIC AND HADRONIC COMPONENTS IN EAS. Castagnoli, Carlo; Picchi, Pio; Verri, Giuseppe (Univ., Turin. CNEN, Frascati, Italy). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 46: 58-63(Jan. 1969).

The arrival time distribution for muonic and hadronic components of the EAS was studied using a Monte Carlo method. Good agreement with experimental results was obtained. (J.F.P.)

3574 CHERENKOV DIPOLE EMISSION IN HIGH-ENERGY ATMOSPHERIC SHOWERS. Bergamasco, Laura (Univ., Turin). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 46: 53-7(Jan. 1969).

Observations are made on the intensity of the Cherenkov radiation emitted at high energies for detection of EAS. The relation with moving dipole very high-energy electron pairs in electron photon cascades in the EAS is discussed. (J.F.P.)

3575 PRECISION MEASUREMENT OF THE g FACTOR OF THE FREE POSITRON. Gilleland, J.; Rich, A. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett. 23: 1130-4(Nov. 10, 1969).

A new measurement of the positron g factor is reported. The result is five times more accurate than the best previous value for this quantity. It shows that the positron and electron g factors are identical to within one part per million. (auth)

3576 SIXTH-ORDER RADIATIVE CORRECTIONS TO THE MUON g-FACTOR. Lautrup, B. E. (Brookhaven National Lab., Upton, N. Y.); de Rafael, E. Nuovo Cim., 64A: 322-4(Nov. 21, 1969).

The contribution to the anomalous magnetic moment of the muon from the Feynman diagrams is found. (auth)

3577 ELECTROMAGNETIC MIXING OF ρ,ω MESONS. Gourdin, M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Stodolsky, L.; Renard, F. M. Phys. Lett., 30B: 347-50(Oct. 27, 1969).

The electromagnetic $\rho-\omega$ is discussed in the light of recent experimental data in the $\omega \to 2\pi$ transition. (auth)

3578 A RELATIVISTIC TREATMENT OF THE THREE-BODY FINAL STATE IN THE PHOTOPRODUCTION OF π ON THE DEUTERON. Leroy, J.-P.; Micheli, J.; Pignon, D. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., B13: 359-74(1969).

The problem of the three-body corrections in final state for particles with spin is studied in view of applying it to the photoproduction on the deuteron: $\gamma d \to NN\pi$. A particular attention is paid to the kinematical singularities of the problem. (auth)

3579 REGGE CUTS AND NEUTRAL PION PHOTOPRODUCTION. Contogouris, A. P.; Lebrun, J. P.; Von Bochman, G. (McGill Univ., Montreal). Nucl. Phys., B13: 246-54 (1969).

Photoproduction of neutral pions on protons is analyzed in terms of models involving exchange of the ω Regge pole and Regge cuts due to ω pole plus the pomeron. The differential cross section in a wide range of energies and the asymmetry ratio are well accounted with a small number of free parameters. (auth)

3580 SINGLE PION PHOTOPRODUCTION IN THE QUARK MODEL. Copley, L. A.; Karl, G.; Obryk, E. (Oxford Univ.). Nucl. Phys., B13: 303-19(1969).

The results are presented of a detailed quark model calculation of the resonance contributions to the total, and backward differential, cross sections for single-pion photoproduction off nucleons. All prominent nucleonic resonances below 2 GeV are considered and assigned to the usual quark configurations with $L^P = 0^+, 1^-, 2^+$. The model is found to be in reasonable agreement with experiment and to predict that the main features of photoproduction off neutrons should be qualitatively different from those off protons. An experimental test is proposed for the presence of the "spin-orbit" radiative coupling in the quark electromagnetic interaction. Finally, the same formalism is used to discuss the radiative decays of the strange $Y_1^*(1520)$ and $Y_1^*(1405)$ resonances. (auth)

3581 MULTIPOLE ANALYSIS OF π^+ PHOTOPRODUCTION WITH LINEARLY POLARIZED γ-RAYS AROUND THE FIRST RESONANCE (W = 1236 MeV). Spillantini, P. (CNEN, Frascati, Italy); Valente, V.; Nigro, M.; Oleari, C. Nucl. Phys., B13: 320-8(1969).

Preliminary results are reported of an analysis of experimental data concerning the photoproduction of π^+ by polarized γ-rays. The total photoproduction amplitude was expanded in multipole amplitudes taking in account multipoles with $l \leq 1$. Some angular distributions of the π^+ cross section calculated by the multipoles are compared with all available experimental points. The results demonstrate the possibility of a completely phenomenological determination of the elementary amplitude in photoproduction. (L.B.S.)

3582 MODEL FOR NON-DIFFRACTIVE CURRENT–CURRENT SCATTERING AMPLITUDES. Bander, M. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., B13: 587-94(1969).

A model for the amplitude obeying the current algebra sum rule is constructed. It satisfies many physical conditions required of this amplitude as analyticity, Regge asymptotics, decreasing from form factors, etc. This amplitude likewise satisfies certain asymptotic sum rules and suggests the possible structure of the difference in elastic electron scattering from members of an SU(3) or SU(2) multiplet. (auth)

3583 DEPENDENCE OF THE AZIMUTHAL ASYMMETRY OF PAIR-PRODUCTION PLANE ON THE PHOTON POLARIZATION. Kel'ner, S. R. (Moscow Engineering-Physics Inst.). Yadern. Fiz.; 10: 605-10(Sep 1969). (In Russian).

Pair production by polarized photons is considered. Azimuthal angle distribution of the pair production plane is obtained in the case when the angle between the electron and the positron momenta is more than a fixed value. The effect of multiple scattering on the azimuthal asymmetry is discussed. The results may be used for experimental determination of the photon polarization parameters. (auth)

3584 POLARIZATION NUCLEAR CORRECTIONS TO μ^- MESON MAGNETIC MOMENT. Batkin, L. S. (Voronezh State Univ., USSR). Yadern. Fiz.; 10: 523-5(Sept. 1969). (In Russian).

Contribution of nuclear polarization to the magnetic moment of the bound μ^- meson is calculated in terms of the theory of finite Fermi systems. Within corrections, magnetic moments of μ^- meson and of μ^+ meson are not different. (auth)

3585 ON THE STATIC ELECTROMAGNETIC SELF-FIELD OF AN ELECTRON. Rosen, G. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim., Lett., 2: 578-80(Oct. 21, 1969).

A tentative theory is reported for the electromagnetic self-field which avoids the problem of solving quantum electrodynamics for the field-theoretic state. (J.F.P.)

3586 COULOMB SCATTERING OF SPIN-½ PARTICLES IN FIVE-DIMENSIONAL THEORY. Bedritskii, A. I. (Vitebsk State Teacher's Inst., USSR). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 4, 129-33(1969). (In Russian).

The states of particles and antiparticles having a ½ spin are classified by five-dimensional equations of the coalescence of the two particles. A matrix of eighth order is selected, and by analogy with the four-dimensional case, a Dirac-conjugate function is introduced. These two equations are obtained from the same Lagrangian. After the transformation of different inversions and of charge conjugation it is possible to describe a number of relations analogous to CPT transformation of four-dimensional quan-

tum field theory. By the use of projective operators it is possible to isolate from the wave function the equations of the coalescence of states referring to different values of the spin projections on the particle momentum. Thus it is possible to carry out a total classification of states, and an expression is derived for the probability of the transition of a particle of spin ½ from one state to another. A formula is obtained for the differential effective scattering cross section. The effective cross sections coincide for a regular particle and for an antiparticle. (TTT)

3587 ASYMPTOTICS OF THE PHOTON AND ELECTRON GREEN FUNCTIONS IN THE $\alpha(\alpha L)^n$ APPROXIMATION. Truten, V. I.; Fomin, P. I. (Inst. of Physics and Tech., Kiev). Zk. Eksp. Teor. Fiz., 57: 1280-9(Oct. 1969). (In Russian).

Asymptotic values of the renormalized (after Dyson) photon and electron Green functions are obtained for large momenta in the so-called $\alpha(\alpha L)^n$ approximation. The gradient transformation for the renormalized electron Green function is considered. (auth)

3588 MOVING BRANCH POINTS AND TWO-BODY INELASTIC REACTIONS. Contogouris, A. P.; Lebrun, J. P. (McGill Univ., Montreal). Nuovo Cim., 64A: 627-48(Dec. 1, 1969).

An approach for calculating Regge-cut contributions in certain two-body inelastic reactions is formulated and it is shown that it leads to amplitudes with all the properties established in dynamical models of cuts in complex angular momentum. With this, a model based on a nonconspiring pion accounts well for near-forward $\gamma p \to \pi^+ n$, with one free parameter which is approximately obtained from independent information. The same model (based on ω Regge exchange) describes well $\gamma p \to \pi^0 p$ for momentum transfers $(-t)^{\frac{1}{2}} \lesssim 1$ GeV; the t-dependence of $d\sigma/dt$ in a wide range of energies and the ratio of cross-sections with polarized photons is obtained with no free parameters. Finally, the model accounts well for the absolute magnitude and variation of $\pi^+ p \to \rho^0 \Delta^{++}$ at small $|t|$. (auth)

3589 FIELD-THEORETIC BOOTSTRAP, VERTEX FUNCTIONS, AND SCATTERING AMPLITUDES AT HIGH MOMENTUM TRANSFER. Stern, H.; Demeyer, R. (Univ., Louvain, Belg.). Nuovo Cim., 64A: 533-45(Dec. 1, 1969).

It is shown to be a consequence of the bootstrap equations that the fully symmetric vertex function in a field-theoretic bootstrap may fall off, asymptotically, faster than any power law for space-like momenta, but can fall only as a power in large timelike momenta. Possible implications are discussed for e-p and p-p elastic scattering. (auth)

3590 LIGHT-CONE COMMUTATOR AND HIGH-ENERGY LEPTON–HADRON INELASTIC SCATTERING. Brandt, Richard A. (Rockefeller Univ., New York). Phys. Rev. Lett., 23: 1260-3(Nov. 24, 1969).

An extension of the chiral $[SU(3) \otimes SU(3)]_{\gamma_5}$ equal-time commutation relations to the light cone is proposed based on a universality defined by the $[SU(3) \otimes SU(3)]_R$ algebra. Consequences concerning asymptotic lepton–hadron inelastic scattering are derived and found to be in good agreement with experiment. (auth)

3591 RELATIONS BETWEEN PION PHOTOPRODUCTION AND πN SCATTERING. Sasaki, Shosuke (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 42: 600-28(Sept. 1969).

The pion photoproduction due to the magnetic moment of nucleon is shown to possess a property similar to πN scattering. The magnetic multipole amplitudes $M_{l\pm}$ are found to be related to the corresponding πN scattering amplitudes $f_{l\pm}$ as $M_{l\pm} = (e\mu_\nu/g)(1/l)(k/q)^l f_{l\pm}$. The proportionality relation is obtained also for the case of electric multipole radiation. The full amplitudes for pion photoproduction are expressed in terms of the amplitudes of the processes $\pi N \to \pi N$ and $\pi N \to \eta N$ without any freely adjustable parameter. Numerical results for differential cross sections and polarizations agree fairly well with the experimental data in the wide energy range 180 ~ 1000 MeV. (auth)

3592 POSSIBILITY OF OBTAINING PION ELECTROMAGNETIC FORM FACTOR FROM HIGH-ENERGY ELECTRO-PION PRODUCTION. Hayashi, Koichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 648-62(Sept. 1969).

The possibility of determining the pion electromagnetic form factor from high energy electro-pion production experiment is discussed. The amplitude is analyzed in the Regge formalism. If the pion belongs to Class II of O(3,1), the electromagnetic form factor of the pion can be determined from the knowledge of the k^2 dependence of the forward amplitude at high energies. Here k is the four-momentum of the virtual photon exchanged in the reaction. Discrimination between type-II and type-III pions is seen from the polarization dependence of the forward cross section. (auth)

3593 EFFECT OF NUCLEON HIGHER RESONANCES ON THE NUCLEON ELECTROMAGNETIC FORM FACTORS. Furuichi, Susumu (Rikkyo Univ., Tokyo); Kanada, Hiroyuki; Watanabe, Keiji. Progr. Theor. Phys. (Kyoto), 42: 744-6(Sept. 1969).

The effects on previous results from including higher nucleon resonances in nucleon electromagnetic form factor calculations are investigated. The contribution of resonances below H waves on $\pi\pi \leftrightarrow N\bar{N}$ amplitudes is found using the narrow width approximation. The higher momentum region is also investigated. The once-subtracted dispersion relations are used for the Sachs form factors, and the cutoff of the dispersion integral is taken at t = 150. (J.F.P.)

Weak

Refer also to abstracts 3763 and 3792.

3594 FINAL-STATE INTERACTIONS IN NONLEPTONIC HYPERON DECAY. Overseth, O. E. (Univ. of Michigan, Ann Arbor); Pakvasa, S. Contract Nonr-1224(23). Phys. Rev., 184: 1663-7(Aug. 25, 1969).

The consequences of including the final-state interactions in the analysis of Λ^0, Σ, and Ξ non-leptonic decays. Emphasis is on the role that the final-state interactions play in tests for T invariance, in tests of the $\Delta I = \frac{1}{2}$ rule (including the resolution of sign ambiguities), and in the determination of the decay amplitudes for these processes. (auth)

3595 CABIBBO ANGLE AND THE BOOTSTRAP EQUATION. McClelland, J. A. (Ohio State Univ., Columbus); Tanaka, K.; Tarjanne, P. Phys. Rev., 184: 1677-80(Aug. 25, 1969).

A solution of the c-number bootstrap equations, $a_i = cd^j_k(a_j a_k + b_j b_k)$ and $b_i = 2cd^j_k a_j b_k$, is obtained, where the amplitudes a_i and b_i represent the matrix elements of unitary octet-vector and axial-vector charges, respectively, d^j_k is the completely symmetric invariant tensor of the third order, the unitary spin indices run from 1 to 8, and c is an arbitrary constant. The solution depends on two parameters, which suggests that the bootstrap equations underdetermine the amplitudes. For a specific value of the parameters, one has a solution which satisfies the Cabibbo theory. It is also found in the present model that if the Cabibbo angle for the vector charges is different from the Cabibbo angle of the axial-vector charges, CP invariance must be violated. The matrix elements of the weak charges can be arbitrarily smaller than those of the electromagnetic charges. (auth)

3596 MASS AND WIDTH OF THE κ MESON AND A STUDY OF K_{l3} FORM FACTORS. McKay, Douglas W.; McKisic, J. Michael; Wada, Walter W. (Ohio State Univ., Columbus). Contract AT(11-1)-1545. Phys. Rev., 184: 1609-16(Aug. 25, 1969).

The dispersive-sum-rule method, which allows the soft-pion results of current algebra to be extrapolated to the physical region, recently developed by Ademollo, Denardo, and Furlan for the vertex function $\langle 0|[A^a_\mu(x), V^b_\nu(0)]|K^\gamma(p)\rangle$, is extended to two other vertex functions. Under the assumptions of the hypothesis of partially conserved axial-vector current, current algebra, pole dominance, and the postulate of a partially conserved vector current (PCVC), with which is associated a strangeness-carrying scalar meson κ, three independent relations were derived involving the kaon mass, the pion mass, the pion decay amplitude, and the four unknowns F_K/F_π, F_κ, $g_{\kappa K\pi}$, and m_κ. For values of F_K/F_π in the range 1.00 to 1.28, the corresponding values of the remaining parameters F_κ, $g_{\kappa K\pi}$, and m_κ were determined. With the choice $F_K/F_\pi = 1.23$ it is found, for example, that $m_\kappa = 1100$ MeV and $\Gamma(\kappa \to K + \pi) = 380$ MeV, consistent with recent experimental results. The κ parameters, however, depend sensitively on the value of F_K/F_π. Fixed-q_i^2 dispersion relations ($q_i^2 = m_i^2$) are written for the K_{l3} form factors f_+ and f_-. Two alternatives are investigated: first, that f_+ is unsubtracted and f_- is superconvergent (via PCVC); and second, that f_+ is once-subtracted and f_- is unsubtracted. In the latter approach, Weinberg's first sum rule under $SU(3) \otimes SU(3)$ is sufficient to evaluate the ξ parameter and the usual constants λ_+ and λ_- which parametrize the K_{l3} form factors. Both alternatives give nearly identical results, and the values obtained are consistent with the experimental data. Of particular note is the result that $f_+(0) = 1.0$ independent of F_K/F_π. (auth)

3597 STRONG COUPLINGS FROM WEAK DECAYS OF PSEUDOSCALAR MESONS. Weiner, Marcel (Syracuse Univ., N. Y.). Phys. Rev., 184: 1782-7(Aug. 25, 1969).

The results of a previous paper are extended. A large and, in a sense, complete class of weak decays of pseudoscalar mesons is considered, all processes being taken to lowest contributing order in both the weak and the strong coupling constants. Convergence requirements allow the determination of several strong coupling constants, consistently with experiment. Electromagnetic decays may be included without additional constraints. Although

the ingredients of the theory are the exact SU(3) currents for the weak interaction, the emerging strong interaction breaks the symmetry to a considerable extent. A basic Lagrangian is assumed which is a simplified version of Cabibbo's phenomenological one. In particular, weak D currents cannot be included to zeroth order in the strong interaction. The partial decay rate is then satisfactorily obtained for $K^+ \to \mu + \nu$ (supplementing the cases $\pi^+ \to \mu + \nu$ and $\pi^0 \to 2\gamma$ discussed in the previous paper): $1/m_{K^+K^+} = 3(g_{N\Lambda^2}/4\pi)\{Gm_\mu \sin\theta_A/(2\pi)^2[1-(m_\mu^2/m_{K^+})]\}[(\Xi-N)(\Sigma-\Lambda)/(\Xi-\Lambda)]\}^2$, $1/m_{\pi^+\pi^+} = 4(g_{NN^2}/4\pi)\{[Gm_\mu \cos\theta_A/(2\pi)^2][1-(m_\mu^2/m_\pi^2)]\ln(\Sigma^2/N\Xi)\}^2$, $1/m_{\pi^+\pi^0} = (g_{NN^2}/4\pi)\{(e^2/4\pi)(m_\pi N/4\pi)[(1/N^2)-(1/\Xi^2)]\}^2$, with $g_{N\Lambda^2}/4\pi \approx 13$, $g_{NN^2}/4\pi \approx 15$, and $\theta_A \approx 16.5°$. (auth)

3598 HARD-MESON CURRENT ALGEBRA AND KAONIC PROCESSES: CONSTRUCTION OF THREE- AND FOUR-POINT FUNCTIONS. Pande, L. K. (Ohio State Univ., Columbus). Phys. Rev., 184: 1683-1700(Aug. 25, 1969).

Three- and four-point functions are constructed which describe the K_{l3} and K_{l4} form factors, K-π scattering, and several strong decay processes. The construction is based on current algebra and the appropriate (full or partial) conservation hypotheses for the various currents involved. Also, the assumption of saturation of all intermediate states by suitable one-particle states is made. On the other hand, no explicit SU(3) invariance is invoked, nor any soft-meson approximations. Applications of the material presented here will be discussed separately. (auth)

3599 CURRENT ALGEBRA, K_{l3}^+ FORM FACTORS, AND RADIATIVE K_{l3}^+ DECAY. Fischbach, E.; Smith, J. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., 184: 1645-60(Aug. 25, 1969).

The complete gauge-invariant matrix element for the decays $K^+ \to \pi^0 l^+ \nu\gamma$ is derived up to and including terms linear in the photon energy k. The contributions of order k^{-1} and k^0 are evaluated through Low's theorem, while the contributions linear in k, which represent the most important structure-dependent terms, are related to the vector and axial-vector couplings in $K^+ \to l^+\nu\gamma$ via the hypothesis of partially conserved axial-vector current (PCAC). It is shown that the spectra and rates from the radiative decay provide an independent means of measuring the K_{l3} parameters $f_+(0)$, ξ, and λ_+. Results are given for the rates and photon spectra in both $K^+ \to \pi^0 e^+\nu\gamma$ and $K^+ \to \pi^0\mu^+\nu\gamma$ decays for representative values of the K_{l3} parameters. With improved experimental data, it is then possible to check the predictions of various theoretical models both for the t dependence of the K_{l3} form factors and for the size of the structure-dependent matrix elements. (auth)

3600 SOME IMPLICATIONS OF A NEW SOURCE OF COSMIC-RAY MUONS. Bjorken, J. D. (Stanford Univ., Calif.); Pakvasa, S.; Simmons, W.; Tuan, S. F. Phys. Rev., 184: 1345-55(Aug. 25, 1969).

Implications of the recent experiment by the University of Utah cosmic-ray group are studied, which presents evidence for a new source of cosmic-ray muons. The data imply the existence of a new class of hadrons X, produced in pairs with a cross section ≥ 0.3 mb in primary cosmic-ray collisions of energy $>10^{12}-10^{13}$ eV. The X, although stable under strong and electromagnetic interactions, decays with large branching ratio into states containing a muon and with lifetime $<10^{-7}-10^{-8}$ sec. The total mass of the produced X pair is estimated to be less than 55 GeV. The possible quantum numbers of X are examined. Possible new interactions of cosmic-ray muons and neutrinos underground are studied. In particular, the muon electromagnetic field should photoproduce X; the cross section for this process is estimated to be $\sim 10^{-32}$ cm^2 and may lead to observation of pairs of muons under ground with small lateral separation or measurable angular divergence. The hypothesis X = W = intermediate boson for the weak interactions is considered; the experimental limits on the production of W by neutrinos and muons underground, along the with absence of large ν-p elastic scattering at accelerator energies, place strong, and possibly fatal, constraints on this interpretation. The importance of the polarization of the muon beam underground in these considerations is pointed out. Finally, further experimental consequences of the existence of X are discussed. (auth)

3601 UNSUBTRACTED DISPERSION RELATION, CURRENT ALGEBRA, AND MOMENTUM-DEPENDENT VECTOR FORM FACTOR IN K_{l4} DECAYS. Dutt, Ranabir; Majumdar, Rabi (Univ. of Delhi). Phys. Rev., 184: 1950-3(Aug. 25, 1969).

The momentum-dependent structure of the vector form factor in K_{l4} decays is obtained by using unsubtracted dispersion relations and hard-meson current algebra. A few of the coupling parameters in terms of which the vector amplitude is expressed are evaluated from the on-mass-shell three-point functions of currents obeying the algebra of SU(3) ⊗ SU(3). The other parameters, involving VVP couplings, are related to the known decay rate for the process $\pi^0 \to \gamma\gamma$. The contributions of the vector form factor to the decay rates and the so-called left-right asymmetry parameter have been obtained and compared with those of the previous calculations. (auth)

3602 NUCLEAR DOUBLE-BETA DECAY AND A NEW LIMIT ON LEPTON NONCONSERVATION. Primakoff, H. (Univ. of Pennsylvania, Philadelphia); Rosen, S. P. Phys. Rev., 184: 1925-33(Aug. 25, 1969).

Nuclear double-β decay is discussed on the assumptions (1) that the process, treated as second-order weak, occurs predominantly without neutrino emission and so violates lepton conservation, and (2) that the matrix element for the process is mainly due to the no-neutrino double-β decay of an isospin-$^3/_2$ nucleon resonance present, albeit with a small ($\approx 1\%$) probability, in the parent or daughter nucleus. The theoretical lifetimes obtained on this basis are compared with the corresponding experimental lifetimes; the various lifetime ratios are correctly predicted, and a limit $\approx 10^{-4}$ is imposed on the relevant "lepton-non-conservation" parameter. A discussion is also given of the convergence problems associated with the matrix elements for second-order weak processes in general. In addition it is shown that in spite of the presence of virtual-neutrino closed loops, divergences never arise in the matrix elements for no-neutrino double-β decay if the basic nuclear constituents (i.e., quarks or nucleons) have isospin not exceeding $^1/_2$ and mean separation greater than zero. (auth)

3603 CABIBBO ANGLE AND SELF-CONSISTENCY CONDITION. Tanaka, K. (Univ. of Helsinki. Ohio State Univ., Columbus); Tarjanne, P. Phys. Rev. Lett. 23: 1137-9(Nov. 10, 1969).

A solution of the c-number self-consistency condition $a_i - d_{ijk}a_ja_k = h_i$ is obtained, where a_i represents the matrix elements of unitary octet vector charge and h_i is a driving term. With a reasonable choice of a driving term, $\sin\theta = 0.22 - 0.14$ is obtained for the Cabibbo angle θ. The choice of h_i that leads to $\tan\theta = m_n/m_\Lambda$ (where m_n and m_Λ are the quark masses) is also pointed out. (auth)

3604 MEASUREMENT OF THE $K_L^0 \to \gamma\gamma$ BRANCHING RATIO. Kunz, Paul Frank. Princeton, N. J., Princeton Univ., 1968. 84p.

Thesis.

A measurement of the branching ratio $K_L^0 \to \gamma\gamma/K_L^0 \to 3\pi$ was made with a spark chamber gamma ray spectrometer and it is compared with theoretical predictions. From this measurement and from the published branching ratio of $K_L^0 \to 3\pi/K_L^0 \to$ all, the branching ratio of $K_L^0 \to \gamma\gamma/K_L^0 \to$ all was found to be $(5.5 \pm 1.1) \times 10^{-4}$. (Disser. Abstr.)

3605 WEAK INTERACTION OF PHOTONS AND THE PROCESS $\gamma + \gamma \to \gamma + \nu + \bar{\nu}$. Chaudhuri, P. R. (Indian Statistical Inst., Calcutta). Nuovo Cim., 64A: 528-32(Dec. 1, 1969).

From the point of view that photons can interact weakly with neutrinos, the cross section for the process $\gamma + \gamma \to \gamma + \nu + \bar{\nu}$ was calculated. From this, the rate of stellar energy loss due to neutrino pair emission and neutrino luminosity of the star in this process was calculated and the result is compared with that obtained on the basis of the current-current coupling theory. (auth)

3606 WEAK INTERACTION OF PHOTONS AND NEUTRINO–ELECTRON SCATTERING. Chaudhuri, P. Ray; Bandyopadhyay, P. (Indian Statistical Inst., Calcutta). Nuovo Cim., 64A: 658-68(Dec. 1, 1969).

The neutrino-electron scattering is discussed according to the photon-neutrino weak-coupling theory. The results are then compared with those obtained in the current-current coupling theory. The rate for neutrino-electron scattering is also discussed for nondegenerate and degenerate gases. Astrophysical applications are then made by evaluating the ratio of the neutrino mean free path to the stellar radius. It is shown that, according to the photon-neutrino weak coupling, the neutrino mean free path exceeds the stellar radius for massive stars, white dwarfs and neutron stars. This result is significant in the sense that according to the current-current coupling theory, the ratio of the neutrino mean free path to the stellar radius for neutron stars can be much less than unity, though for other types of stars the neutrino mean free path exceeds the stellar radius. Finally, some remarks are made about the experiment attempted by Reines and Kropp to detect solar neutrinos using knock-on electrons produced in the neutrino-electron scattering. (auth)

3607 IMPLICATIONS OF DEEP INELASTIC MUON–NUCLEON SCATTERING ON COSMIC-RAY PHENOMENA. Castagnoli, C. (CNR, Turin); Etim, E.; Picchi, P. Nuovo Cim., Lett., 2: 595-9(Oct. 21, 1969).

It is shown by analysis of cosmic-ray experiments that for

large values of the photon energy $\nu \to \infty$ the validity of the equation containing a convergent series for cross sections for the absorption of transverse photons on a nucleon for small values of the invariant momentum transfer is in doubt and a different approach is to be preferred. It is also shown that the Bjorken inelastic sum rule for asymptotic cross sections is not saturated. This convergent series is used for analyses of inelastic meson (μ)-nucleon scattering. (J.F.P.)

3608 DIVERGENCES OF AMPLITUDES OF WEAK NONLEPTONIC PROCESSES IN THE THEORY WITH AN INTERMEDIATE BOSON. Vainshtein, A. I.; Ioffe, B. L. JETP Lett. (USSR) (Engl. Transl.), 10: 57-9(July 20, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 10: 91-5(July 20, 1969).

An estimate is presented of the diverging terms in the amplitudes of weak nonleptonic processes without using a previous assumption. Also the resultant values of the cutoff parameter are found. The main assumption used is that in the limit of zero pion mass the axial current with $\Delta S = 0$ is rigorously conserved. (J.F.P.)

3609 NEUTRINO PRODUCTION OF BARYONS WITH ANY SPIN. Iwata, Takashi; Takemura, Tadao; Kobayashi, Tsunehiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 42: 676-91(Sept. 1969).

Production of baryons and baryon resonances by neutrino and antineutrino $\nu(\bar{\nu}) + N \to \beta + l(\bar{l})$ is discussed. Under the assumption that the leptonic current obeys the V-A type, the hadronic factor of the matrix element is written by the helicity formalism. Time reversal invariance and PCAC for the hadronic current in the resonance production processes are investigated. In the light of the quark model, PCAC in the resonance production processes is studied and numerical results are given for $d\sigma/dq^2(\nu + p \to N_{33}^{*++} + l^-)|_{q^2=0}$. (auth)

3610 EFFECTIVE HAMILTONIAN OF WEAK INTERACTION AND QUARTET MODEL. Katuya, Mituaki; Koide, Yoshio (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 42: 663-75(Sept. 1969).

According to the quartet model, an attempt is made to obtain a unified understanding of the various features of the weak interaction. In order to obtain the effective Hamiltonian for elementary particles, "translation" rules from a set of urbaryon fields to a hadron field are assumed. On the basis of these rules, it is shown that all the semileptonic decays originate in the interaction $J_\mu l^{\mu\dagger}$ + h.c., where the l_μ are lepton currents and the J_μ are urbaryon currents, and all the nonleptonic decays originate in the two-body transition $t_3 \to t_2$ which is reduced to the interaction $l_\mu l^{\mu\dagger}$ by the Hiroshima model. (auth)

3611 DUALITY AND NONLEPTONIC HYPERON DECAY. Nussinov, Shmuel el Aviv Univ., Ramat Aviv, Israel); Rosner, Jonathan L. Phys. Rev. Lett., 23: 1264-6(Nov. 24, 1969).

Duality reproduces most current-algebra results and leads to octet enhancement for S-wave nonleptonic decays of baryons. Reasons for its inapplicability to P-wave decays are given. (auth)

Strong (General)

Refer also to abstracts 3597, 3627, 3691, 3780, and 3785.

3612 (SJC-P-68-6) POSSIBLE MECHANISM OF DIRECT PRODUCTION OF MUON PAIRS AT HIGH ENERGIES. Hayakawa, Satio; Kikuchi, Ken (Tokyo Univ. (Japan). Inst. for Nuclear Study). Nov. 1968. 4p. Dep. CFSTI (U. S. Sales Only).

It is pointed out that the production of muon pairs is inherent in high-energy nuclear interactions which take place through complex intermediate states called fire balls. The direct pair emission width and cross section are derived. The fire ball interactions are also caused from the nuclear interaction of the muon. The incident muon produces a fire ball which then decays into mesons. The cross section for this process is calculated. (J.F.P.)

3613 OFF-MASS-SHELL THEORY OF THE BOOTSTRAP AND COMPOSITE-PARTICLE SCATTERING. Harte, John (Yale Univ., New Haven). Phys. Rev., 184: 1936-47(Aug. 25, 1969).

Previous work on a crossing-symmetric bootstrap model for the asymptotic vertex function is generalized to an analysis of the asymptotic behavior of composite-particle scattering amplitudes. Using off-mass-shell integral equations, but making no reference to field theory, a complete, unitary, crossing-symmetric bootstrap theory is constructed and a consistent asymptotic solution for all of the n-particle amplitudes is obtained. The asymptotic prediction for the two-body scattering amplitude, valid in the limit in which $|s|$, $|t|$, and $|u|$ approach infinity, is compared with the qualitative features of the wide-angle proton–proton scattering data, and a severe restriction is thereby placed on the asymptotic rate of decrease of the hadronic vertex functions. This restriction is consistent with a new lower bound, $F(t) \geq ce^{-b(-t)^{1/4}}$ for $t \to \infty$, on the hadronic form factors, which is derived here under the assumption of the Wick rotatability of the Bethe–Salpeter equation. While previous nonrelativistic "bootstrap" models predict $F(t) = ce^{-b(-t)^{1/2}}$, the fourth-root behavior is shown to be consistent with the relativistic bootstrap theory. (auth)

3614 THEORY OF CURRENTS WITHOUT TOO MUCH SYMMETRY. Cronin, J. A.; Guralnik, G. S. (Brown Univ., Providence). Phys. Rev., 184: 1803-5(Aug. 25, 1969).

It is shown that it is possible to have a theory of currents without parity doubling if the algebra-of-fields commutation relations are changed by the introduction of operator Schwinger terms. In addition, it is necessary to impose a relationship among the currents generating the theory. The nonlinear formulation of the σ model involving only the pion field is shown to be an example with these properties. (auth)

3615 SIMPLIFIED INTEGRAL EQUATION FOR THE MULTIPERIPHERAL BOOTSTRAP. Goldberger, Marvin L.; Tan, Chung-I; Wang, Jiunn-ming (Princeton Univ., N. J.). Contract AF49(638)-1545. Phys. Rev., 184: 1920-22(Aug. 25, 1969).

An integral equation for the two-body absorptive amplitude based on the multiperipheral model is proposed. The general property and the bootstrap potentiality of the equation are discussed. (auth)

3616 ANALYTIC SOLUTION OF THE LINEAR-TRAJECTORY BOOTSTRAP. Bardakci, K.; Mandelstam, S. (Univ. of California, Berkeley). Phys. Rev., 184: 1640-4(Aug. 25, 1969).

The quark-model bootstrap previously proposed is extended to include the lower trajectories. The extension is obtained by showing that the factorization properties of the multiparticle Veneziano amplitude can be generalized to the resonances on the lower trajectories. All trajectories other than the leading trajectory are degenerate, and the degeneracy increases rapidly as we go downward. Apart from the fundamental narrow-resonance approximation, the solution of the bootstrap model is exact. If we make a hypothesis regarding the simplicity of the spectrum of the lower trajectories, then the solution appears to be unique to within a finite number of constants. The inconsistency associated with negative widths remains, and any improvement in this respect will probably require going beyond the narrow-resonance approximation. (auth)

3617 ELASTIC DIFFRACTION SCATTERING OF HADRONS AT HIGH ENERGIES. Chow, G. Y.; Rix, J. (Case Western Reserve Univ., Cleveland). Phys. Rev., 184: 1714-28(Aug. 25, 1969).

A new model for the high-energy ($p_{lab} \geq 4$ GeV/c) diffraction scattering of hadrons is presented. This shadow-scattering model explains, quantitatively, the magnitude and energy dependence of the widths of elastic-scattering diffraction peaks. An improved approximation for the inelastic intermediate states is used which emphasizes the role of quasielastic scattering and of optical absorption with energy-independent opacity. The quasielastic scattering is calculated from Feynman diagrams, while the optical absorption is constrained by the observed total cross section. Unitarity and one energy-independent scale-fixing parameter, then, give quantitative predictions for the widths of diffraction peaks which are only weakly dependent on the assumed l dependence of the optical absorption. (auth)

3618 UNEQUAL-MASS BOOTSTRAP USING FINITE-ENERGY SUM RULES. Jacobs, Matthew A.; Vaughn, Mark H. (Univ. of California, San Diego, La Jolla). Phys. Rev., 184: 1877-84(Aug. 25, 1969).

Mandelstam's $N\bar{N}$ bootstrap of the ρ, A_1, and π trajectories, employing finite-energy sum rules, is generalized to unequal-mass kinematics. Various problems associated with the unequal-mass kinematics are discussed: the explicit form of the crossing matrix, the unequal-mass invariant amplitudes, the mass dependence of the Regge residues, and the kinematic constraints. A bootstrap is described for slightly unequal masses to obtain the stability of the bootstrap against broken-mass asymmetry. It is found to be comparatively stable against mass splittings. (auth)

3619 GAUGE THEORY OF STRONG INTERACTIONS. O'Donnell, P. J. (Univ. of Toronto). Phys. Rev., 184: 1728-31(Aug. 25, 1969).

A generalization of gauge invariance in strong interactions is given. This leads naturally to a structure of $[U(3)]^4$ with the gauge fields corresponding to the quantum numbers $J^{PC} = 1^{2+}$, 1^{+}, 1^{2-}, 1^{-}. Currents of both first- and second-class types are present. A tentative assignment of the gauge fields to possible resonances is made. (auth)

3620 NONRELATIVISTIC MODEL OF HADRONS AS BOUND STATES OF N FERMIONS. Wimmer, Peter L. (Univ. of Miami, Coral Gables, Fla.). Phys. Rev., 184: 1510-22(Aug. 25, 1969).

A nonrelativistic model of hadrons as N-fermion bound states is proposed. It is concerned with the relative motion of the subparticles and the intrinsic spins of the fermions; the dependence on center-of-mass and internal variables (isospin, hypercharge, etc.) are separated out. Eigenvalue equations for the total angular momentum, parity, and mass are written down, with the requirement of invariance under the Born reciprocity principle applied to the relative coordinates and momenta. Ladder operators connecting different states are derived and are used to construct all solutions from a ground state. The solutions for three-fermion bound states are applied to baryonic resonances, yielding mass formulas for N^*, Y_6^*, and Y_7^* resonances. (auth)

3621 TWISTED PROPAGATOR IN THE OPERATORIAL DUALITY FORMALISM. Caneschi, L. (Univ. of California, Santa Barbara); Schwimmer, A.; Veneziano, G. Phys. Lett., 30B: 351-6(Oct. 27, 1969).

An explicit operatorial form is found which represents the "twisted" lines in the duality diagrams. Some applications, and in particular the derivation of the symmetric three-resonance vertices, are discussed. (auth)

3622 QUARK MODEL SELECTION RULES FOR HADRON COUPLINGS. Freund, P. G. O. (Univ. of Chicago); Waltz, R.; Rosner, J. Contracts AT(11-1)-264; AT(11-1)-1764. Nucl. Phys., B13: 237-45(1969).

Quark model selection rules are derived which apply to the couplings of hadrons composed of any number of quarks. These reduce to well-known and experimentally verified rules in the simplest cases, provide a necessary selection rule in the application of duality to baryon-antibaryon systems, and could explain the apparent difficulty of producing free quarks. Some experimental consequences of the rules are discussed. (auth)

3623 THE LONG-LIVED HADRONS. Lewis, D. T. (Lab. of the Government Chemist, London). Lab. Pract., 18: 1047-51; 1062(Oct. 1969).

The three-entity theory for the generic structure of sub-nuclear particles is developed. (auth) (UK)

Strong (Baryon No. = 0)

Refer also to abstracts 3562, 3598, 3618, 3722, and 3783.

3624 (ITF-69-47) FORMULATION OF THE ρ-BOOTSTRAP WITH EXACT UNITARITY. Chermalykh, G. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Theoreticheskoi Fiziki). 1969. 12p. (CONF-690417-18). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

Using the fact that dispersion relation for the real part of the partial-wave amplitude is a singular integral equation relative to the inelasticity coefficient $\eta_s(\nu)$ (at a given real part of the phase shift $\mathrm{Re}S_s$ and imaginary part of the partial-wave amplitude on the left-hand cut) and solving this equation with subsequent accounting of the crossing symmetry and conserving only P-waves in the crossed channels, the linear integral equation is formulated for $\eta_{s=1}^{I=1}(\nu)$ as the ρ-bootstrap equation with exact unitarity in all the three channels. (auth)

3625 APPLICATION OF THE RELATIVISTIC SCHROEDINGER EQUATION TO THE BOOTSTRAP PROBLEM. Boguta, John Joseph. Urbana, Ill., Univ. of Illinois, 1968. 77p.

Thesis.

The relativistic Schrödinger equation is used to investigate the meson bootstrap problem. The forces are computed from the usual Feynman graphs for single particle exchanges. At first, pseudoscalar-pseudoscalar meson scattering is considered in a multichannel calculation. The vector mesons obtained are recombined with the pseudoscalars, and multichannel vector-pseudoscalar scattering is studied. The pseudoscalars themselves are obtained as bound states as well as a set of axial vector meson resonances. (Diss. Abstr. Int., B)

3626 UNIQUENESS OF THE S MATRIX FOR A CLASS OF CHIRAL LAGRANGIANS. Bessler, LeRoy (Univ. of Wisconsin, Milwaukee). Phys. Rev., 184: 1523-6(Aug. 25, 1969).

The general pion-nucleon Lagrangian is constructed for a certain infinite class of nonlinear realizations of chiral $SU(2) \times SU(2)$; the symmetry-breaking term is the isoscalar component of a chiral tensor of rank n. By explicit calculation, the π-π scattering lengths are shown to be the same for all choices of the nonlinear realization. For both π-π and π-N scattering, it is found that for fixed n the S matrix, diagram by diagram and in the tree approximation, is unique, and that it remains unique if ρ mesons are introduced. (auth)

3627 RELATIVISTIC QUARK MODEL BASED ON THE VENEZIANO REPRESENTATION. I. MESON TRAJECTORIES. Mandelstam, Stanley (Univ. of California, Berkeley). Phys. Rev., 184: 1625-39(Aug. 25, 1969).

A bootstrap dynamical scheme is based on the Veneziano model. It is assumed that the internal trajectories in all channels are similar in their spin and isotopic-spin properties to the external particles, and that vertices are symmetric in their internal and external particles. It turns out that quarks form a very useful entity for expressing the solution, even though the system contains no physical quarks. The spin and multiplicity of the quarks are not determined by the solution, but must be assumed. The spectrum of particles is the same as that predicted by the nonrelativistic quark model, and the particles from multiplets of SU(6). The trajectories of the system, on the other hand, form multiplets of SU(12) or SU(6,6), and they are doubled both in their parity and in their Toller M value. Some of the trajectories have residues whose sign corresponds to repulsion rather than attraction, and an interpretation of such trajectories is suggested. If ρ universality is assumed in order to fix certain parameters, all further coupling constants can be determined to within a scale factor, and the vertices are those predicted by $SU(6)_W$. In much of the work the detailed form of the Veneziano model is not used, and a comparison is given with certain previous approaches. (auth)

3628 EXTERNAL SPIN CONTINUATION IN A THREE-CHANNEL ρ BOOTSTRAP. Thiebaux, M. L. (Univ. of Massachusetts, Amherst). Phys. Rev., 184: 1769-78(Aug. 25, 1969).

External spin continuation is proposed in a three-channel self-consistent ρ bootstrap in which the channels are composed of pions and first pion recurrences. Emphasis is placed on presenting those aspects of the problem that may survive generalization to other multichannel bootstrap situations. The relationship between the existence of recurrences and the statement of unitarity is studied in an endeavor to treat internal and external particles more uniformly than in a previously proposed one-channel problem. Unconventional amplitudes are constructed which, unlike the conventional helicity amplitudes, possess the property that kinematic zeros are uniformly factorizable under external spin continuation. The set of spin-dependent coupling constants introduced into the problem satisfies a number of constraints due to the nonexistence of certain types of couplings, to Bose–Einstein statistics, and to redundancies in the channel definitions. Crossing relations, unitarity, and a unitarization procedure for the unconventional amplitudes are formulated. (auth)

3629 INTERFERENCE EFFECTS AND CORRECTIONS IN $A_1 \to 3\pi$ AND $A_2 \to 3\pi$ DECAYS. Goldberg, Hyman (Northeastern Univ., Boston). Phys. Rev., 184: 1778-81(Aug. 25, 1969).

Corrections due to overlapping ρ and σ bands in the decay $A_1 \to 3\pi$, and ρ bands in $A_2 \to 3\pi$, are evaluated to first order in the ρ and σ widths. The corrections in the case of the A_1 indicate the use of a smaller anomalous magnetic moment λ_A (or δ) than was previously needed to fit the width of the A_1. (auth)

3630 SPIN-MATRIX POLYNOMIALS AND THE VENEZIANO FORMULA. Nelson, T. J. (Univ. of California, Berkeley). Phys. Rev., 184: 1954-5(Aug. 25, 1969).

A partial-wave expansion for $\pi\pi \to \pi\omega$ is considered in terms of the spin-matrix polynomials $W_n(z) = \Gamma(z + \frac{1}{2}n + \frac{1}{2})/\Gamma(z - \frac{1}{2}n + \frac{1}{2})$ rather than the conventional Legendre polynomials. This leads naturally to Veneziano's formula when his supplementary condition $\alpha(s) + \alpha(t) + \alpha(u) = 2$ is invoked. (auth)

3631 CONSISTENCY CONDITION DUE TO THE PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT IN THE VENEZIANO MODEL. Kawarabayashi, Ken; Kitakado, Shinsaku; Yabuki, Haruichi (Kyoto Univ.). Phys. Rev., 184: 1956(Aug. 25, 1969).

The consistency condition due to the partial conservation of axial-vector current is discussed within the framework of the Veneziano model. It is pointed out that the soft-K condition does not necessarily lead to SU(3)-degenerate masses, as opposed to the result of Ademollo, Veneziano, and Weinberg. (auth)

3632 VENEZIANO AMPLITUDES AND THE $\pi\omega\rho\sigma A_1$ SYSTEM. Zee, A. (Harvard Univ., Cambridge, Mass.). Contract 1866 (55). Phys. Rev., 184: 1922-4(Aug. 25, 1969).

Veneziano amplitudes are written for all reactions involving the $\pi\omega\rho\sigma A_1$ system, paying particular attention to kinematical constraints arising from spin. The minimal Veneziano amplitude for $A_1 \rightarrow 3\pi$ is shown to be dependent on two parameters, which may be related to the $A_1\rho\pi$ vertex. A discussion is given on how examination of the Dalitz plot may resolve the theoretical confusion surrounding the A_1. (auth)

3633 CURRENT ALGEBRA, UNITARITY, AND THE SCALAR MESON. Greenberg, David F. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., 184: 1934-6(Aug. 25, 1969).

Current-algebra results for low-energy pion-pion scattering are combined with unitarity and an effective-range expansion to predict the width of a scalar meson and the I = 0 s-wave phase shifts from threshold to 1 BeV. (auth)

3634 EXTENDED QUARK-REARRANGEMENT MODEL FOR PROTON-ANTIPROTON ANNIHILATION AT REST. Carroll, J. P. (Indiana Univ., Bloomington). Phys. Rev., 184: 1793-1802(Aug. 25, 1969).

A model is presented which is an extension of Rubinstein and Stern's quark-rearrangement model. Baryons and mesons are assumed to be classified in ladder representations of U(6) × U(6). A general formula is given which can be used to project out the 56 or 35 from any representation in the U(6) × U(6) ladder. Branching ratios for proton-antiproton annihilation are derived in the extended model from the projection of the proton-antiproton pair onto all possible meson final states. The details are worked out for the cases of two and three mesons. There are several general features which seem to agree qualitatively with experiments. (auth)

3635 DOUBLE SPECTRAL APPROXIMATION FOR PION SCATTERING. Franklin, Jerrold (Temple Univ., Philadelphia). Phys. Rev., 184: 1873-6(Aug. 25, 1969).

The double spectral functions in the Mandelstam representation are approximated by a zero-width approximation that reproduces elastic crossed-channel resonances. The partial-wave potential generated by this double-spectral function has a right-hand cut which, for pion scattering, must correspond to inelastic scattering in the direct channel. The Frye–Warnock modification of the ND^{-1} method for inelasticity can then be used. The potential is convergent enough that no cutoff is required. Self-consistency in a bootstrap calculation is achieved by attaining proper threshold behavior rather than using the zero-width approximation in the direct channel. (auth)

3636 THE $\rho \rightarrow 4\pi$ VERTEX IN CHIRAL DYNAMICS. Banyai, L.; Rittenberg, V. (Inst. of Physics, Bucharest). Phys. Rev., 184: 1903-5(Aug. 25, 1969).

The $\rho \rightarrow 4\pi$ vertex was computed assuming vector-meson dominance, and the resulting interaction is described by a chiral-symmetric nonlinear Lagrangian plus a symmetry-breaking term with tensorial properties. The vertex function is used to compute an approximative analytical expression for the $e^+e^- \rightarrow 4\pi$ cross section which is valid from the threshold up to 850 MeV. For the four-pion decay of the ρ meson, the following branching ratios were obtained: $\Gamma_{\rho^0\rightarrow 2\pi^+2\pi^-}/\Gamma_{\rho^0\rightarrow\pi^+\pi^-} \approx 10^{-4}$; $\Gamma_{\rho^0\rightarrow 2\pi^0\pi^+\pi^-}/\Gamma_{\rho^0\rightarrow 2\pi^+2\pi^-} = 1/4$; $\Gamma_{\rho^+\rightarrow 2\pi^+\pi^-\pi^0}/\Gamma_{\rho^0\rightarrow 2\pi^+2\pi^-} = 3/4$. Experiment indicates upper limits of the order 1.5×10^{-3} for the four-pion decay-mode branching ratios. (auth)

3637 VENEZIANO REPRESENTATION FOR $N\bar{N}$ SCATTERING. Jacobs, Matthew A. (Univ. of California, San Diego, La Jolla). Phys. Rev., 184: 1574-7(Aug. 25, 1969).

Linear combinations of Veneziano terms, starting at J = 0,1, are written for the invariant amplitudes in $\Lambda\bar{\Lambda} \rightarrow \Lambda\bar{\Lambda}$ and $N\bar{N} \rightarrow N\bar{N}$ scattering. Using only the π, ρ, and Pomeranchuk trajectories, the residues in helicity amplitudes at J = 0,1,2 along these trajectories are required to correspond to the boson spectrum. Then, it is found that the requirements of reality and factorization of coupling constants for the parent particles are impossible to impose. In addition, the coupling of the pion and the η are found to be zero to the accuracy of the calculation. (auth)

3638 DOLEN–HORN–SCHMID DUALITY AND THE NONEXISTENCE OF MESONS WITH NATURAL PARITY AND ODD CP. Schwimmer, Adam (Weizmann Inst. of Science, Rehovoth, Israel). Contract F-61052-68-C-0070. Phys. Rev., 184: 1508-10 (Aug. 25, 1969).

It is shown that the resonance–Regge-pole duality, together with the nonexistence of nonstrange mesons with natural parity and odd CP, implies exchange degeneracy for the isospin-0 and -1 tensor and vector-meson trajectories, canonical (quark-model) mixing angles for the tensor and vector-meson nonets, and decoupling of the f^* from the $\pi\pi$ and the ϕ from the $\pi\rho$ system. The absence of exotic states is not assumed. (auth)

3639 HIGH-ENERGY CONTRIBUTIONS TO CURRENT-ALGEBRA SUM RULES. II. Vasavada, Kashyap V. (Univ. of Connecticut, Storrs). Phys. Rev., 184: 1594-1601(Aug. 25, 1969).

A method, discussed in a previous paper, of evaluating the high-energy contributions to current-algebra sum rules is applied to several well-known sum rules. These include (i) the Adler–Weisberger sum rule for the π-π system, using π-π phase shifts, (ii) the Cabibbo–Radicati sum rule, (iii) π-N rules, and (iv) the π-N spin-flip sum rule. In the case of the π-π Adler–Weisberger sum rule, a substantial high-energy contribution is obtained which makes the sum rule inconsistent with a very large width of the σ meson (>400 MeV) for m_σ = 730 MeV. The π-ρ sum rules favor a small width for the ρ (≈100 to 120 MeV) and the A_1 meson (<100 MeV). (auth)

3640 FACTORIZATION CONSTRAINTS ON THE VENEZIANO MODEL. Kugler, M.; Milgrom, M. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., B13: 294-302(1969).

Factorization of the resonances appearing in the Veneziano model is discussed. It is required that a pole in a partial wave amplitude corresponds to a single resonance. Strong constraints on scattering amplitudes result from considering pseudoscalar and scalar mesons. Difficulties arise in antibaryon-baryon scattering. Some experimental consequences are discussed. (auth)

3641 RESONANCE RECOGNITION CRITERIA IN A VENEZIANO MODEL. Phillips, R. J. N.; Ringland, G. A. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B13: 274-82(1969).

Various criteria for recognizing resonances in partial wave amplitudes, and for extracting the resonance parameters, are tested numerically in a Veneziano model for the reaction $\pi + \pi \rightarrow \pi + \omega$. The best index of resonance position is the velocity maximum, with respect to energy, in the Argand plot. Resonance parameters can be found approximately by fitting to a pole-plus-background formula. Subtracting a Regge exchange background (not unique) does not generally improve the results. Local duality is not satisfied. (auth)

3642 VENEZIANO MODEL RESULTS FROM AN ISOBARIC MODEL. Boguta, J. (Univ., Bonn). Nucl. Phys., B13: 537-44(1969).

A simple isobaric model is constructed which reproduces correctly the predictions of the Veneziano model. The $\pi\pi$, πK scattering lengths, η and τ decay and $\bar{p}n$ annihilation into 3π are considered. The isobaric model is constructed so that it exhibits PCAC and other intimately related zeroes of the Veneziano model. (auth)

3643 CORRELATION EFFECTS BETWEEN PIONS IN THE REACTIONS $\bar{p}p$-$n\pi$. Roberts, R. C. (CERN, Geneva). Nucl. Phys., B13: 662-70(1969).

Using Lovelace's $\pi\pi$ phase shifts, a model based upon the Reggeized multiperipheral model is constructed which can explain many of the features observed in the processes $\bar{p}p \rightarrow n\pi$ above ~ 2.5 GeV/c. An improvement upon previous models is the good agreement achieved for the Goldhaber effect. (auth)

3644 CROSSING-SYMMETRIC REGGE-POLE MODEL FOR π-π SCATTERING. Moffat, J. W. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., 64A: 485-93 (Dec. 1, 1969).

An interference model of π-π scattering is constructed which possesses linearly rising trajectories, Regge behavior, resonances in all channels and is crossing symmetric. The model satisfies the Adler condition and predicts the Weinberg scattering lengths to within 10%. The calculated partial widths of the resonances associated with the leading trajectory are in reasonable agreement with experiment. (auth)

3645 APPROXIMATELY SELF-CONSISTENT CALCULATION OF THE RHO MESON. Abbe, W. J.; Gary, G. A. (Univ. of Georgia, Athens). Nuovo Cim., 64A: 574-84(Dec. 1, 1969).

An approximately self-consistent calculation of the I = 1 channel (rho-meson) of the pi-pi system is made. The I = 0 channel is put in from experiment, while the rho channel is described by a three-parameter trajectory and two-parameter distribution function in a one-trajectory modified Cheng representation. An attempt to determine the five free parameters from the crossing relations yields a mass and width of the rho of 762 MeV and 120 MeV, respectively. (auth)

3646 CROSSING-SYMMETRY CONSTRAINTS ON PARTIAL-WAVE AMPLITUDES AND THEIR PHYSICAL CONTENT. Basdevant, J. L.; Cohen-Tannoudji, G.; Morel, A. (CERN, Geneva). Nuovo Cim., 64A: 585-602(Dec. 1, 1969).

A very simple derivation of a complete set of sum rules implied by crossing symmetry on partial-wave amplitude is given. This

set is shown to be equivalent to the Balachandran-Nuyts crossing relations for partial-wave amplitudes. Many applications to dynamical models are proposed and discussed, and it is shown in particular that the Padé treatment of the $\lambda\varphi^4$ theory for $\pi\pi$ scattering yields extremely good agreement with crossing symmetry. (auth)

3647 RESONANCE SATURATION OF AXIAL CHARGE COMMUTATOR AND THE πK SCATTERING AMPLITUDE OF THE VENEZIANO TYPE. Tokuda, Naoki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 641-7(Sept. 1969).

Resonance saturation of axial charge commutator taken between states of the K meson is examined with the knowledge of the πK scattering amplitude of the Veneziano type. Contribution of the resonances of the leading trajectory is evaluated to be 60% or so of the value expected from the sum rule. On the other hand inclusion of all the resonances of the daughter trajectories makes it larger than the value. It is necessary to add satellite terms to the πK scattering amplitude, otherwise the experimental value for the decay width of K^* meson should be changed to a smaller one. (auth)

3648 CONSTRAINTS ON MOMENTS OF S-WAVE PION–PION AMPLITUDES RESULTING FROM CROSSING SYMMETRY AND POSITIVITY PROPERTIES OF ABSORPTIVE PARTS. Piguet, O.; Wanders, G. (Univ., Lausanne, Switzerland). Phys. Lett., 30B: 418-20(Nov. 10, 1969).

New conditions on moments of S-wave pion-pion amplitudes over the interval between the left- and right-hand cuts are derived from crossing symmetry and positivity properties of the absorptive parts. They are applied to the model of Iliopoulos. (auth)

3649 NEUTRAL DECAY MODES OF THE ω^0-MESON. Deinet, W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Menzione, A.; Mueller, H.; Staudenmaier, H. M.; Buniatov, S.; Schmitt, D. Phys. Lett., 30B: 426-9(Nov. 10, 1969).

The neutral decay modes of the ω^0 were studied in the reaction $\pi^- + p \rightarrow n + \omega^0$ at 1.51 GeV/c. The branching ratio $(\omega \rightarrow \text{neutrals})/(\omega \rightarrow \text{total}) = (7.9 \pm 1.9)\%$ was determined and limits are given for $(\omega \rightarrow \eta^0\gamma)/(\omega \rightarrow \text{neutrals}) < 24\%$, $(\omega \rightarrow \pi^0\pi^0\gamma)/(\omega \rightarrow \text{neutrals}) < 19\%$, $(\omega \rightarrow \pi^0\gamma)/(\omega \rightarrow \text{neutrals}) > 81\%$ with 90% of confidence. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 3521, 3588, and 3639.

3650 (CEA-R-3578) PARTIAL-WAVE ANALYSIS OF PION–NUCLEON ELASTIC SCATTERING BELOW 1.6 GeV. Bareyre, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 83p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay, France.

Experimental results of pion-nucleon elastic scattering below 1.6 GeV (total cross sections, angular distributions of elastic scattering and recoil nucleon polarizations) are described by a partial wave analysis. This analysis was developed, one energy at a time, with a method of least squares fits. A single solution is extracted by continuity with energy of the different solutions. Resonating behavior is clearly established for several partial waves. In addition to these important effects some phase shifts show rapid variations with energy. The present experimental situation does not permit one to say whether these variations are due to experimental biases or to physical effects. (auth)

3651 (DESY-69/40) VECTOR DOMINANCE AND FORWARD PHOTOPRODUCTION OF CHARGED PIONS. Dar, A. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct. 1969. 14p. Dep. CFSTI (U. S. Sales Only).

The validity of vector meson dominance (VMD) relations between photon initiated reactions and vector-meson initiated reactions is investigated within the framework of realistic models for high energy exchange reactions. The models suggest that the VMD relations should be valid at high enough energy, in the helicity frame. In particular the narrow forward structure that has been found in photon initiated reactions should be found also in the analogous hadron reactions, at high enough energy. (auth)

3652 (UCRL-50617) DETERMINATION OF $\overline{K}N$ ELASTIC SCATTERING AMPLITUDES. Bailey, David Saal (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 1969. 98p. Dep. CFSTI.

Thesis.

A phase shift analysis was used to determine the $\overline{K}N$ elastic partial wave amplitudes below 1.4 GeV/c laboratory momentum. The analysis used a separation of the partial wave amplitudes into resonant and nonresonant parts. Several parametrizations of the background amplitudes were tried. The phase shift results for the nonresonant amplitudes indicate a dominance by the $J = \frac{1}{2}$ states. The necessity for using known resonant states was demonstrated, the parity assignments of the more elastic resonances were confirmed, and a new resonance in the P_{01} state is suggested. As a partial validation of the parametrizations employed and a precursor to a many-channel analysis, a three-channel S-wave model calculation was performed. (auth)

3653 MODEL OF THE BARYON GROUND STATE. Golowich, E. (Univ. of Massachusetts, Amherst). Phys. Rev., 184: 1815-24(Aug. 25, 1969).

A bootstrap description of the lowest-mass states with baryon number one is constructed. A fundamental consideration in this approach is the selection of the most important two-particle channels coupled to these ground-state baryons. It is suggested that S- and P-wave couplings to meson-baryon composites dominate, and that existing evidence from decays of resonant states supports our idea. A theoretical description which fits in naturally with this observation is the SU(6)-multiplet classification of baryon states first formulated by Capps and by Belinfante and Cutkosky. This symmetry of S- and P-wave baryon-interaction vertices may be viewed as an extension of the original Chew–Low static interaction. The dynamical basis for the model is a set of bootstrap equations implied by the Bethe–Salpeter equation. Positive- and negative-parity baryons are assigned to 56^+ and 70^-, respectively, and the 70^- to 56^+ mass difference, as well as the $56^+56^+35^-$, $70^-_F70^-35^-$, and $70^-_D70^-35^-$ P-wave and the $70^-56^+35^-$ S-wave coupling constants are determined. A 70^- to 56^+ mass difference of 230 MeV, and a 70^- F/D ratio of -1.1 are calculated. The relation of the model to ρ-universality and also the parity-doublet conjecture for baryons is discussed. (auth)

3654 PION–NUCLEON SCATTERING IN THE VENEZIANO REPRESENTATION. Bose, S. K.; Gupta, K. C. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-427. Phys. Rev., 184: 1572-3(Aug. 25, 1969).

The leading Veneziano terms for low-energy π-N scattering are studied. It is found that they do not provide an acceptable model for low-energy scattering. (auth)

3655 NUCLEON ISOBAR EXCITATION IN π^+p SCATTERING. Hendry, Archibald W.; Trefil, J. S. (Univ. of Illinois, Urbana). Phys. Rev., 184: 1680-2(Aug. 25, 1969).

The major differences in the differential cross sections for $\pi p \rightarrow \pi p$, $\pi p \rightarrow \pi N^*(1.4)$ and $\pi p \rightarrow \pi N^*(1.69)$ are explained on the basis of composite structure for the nucleon and its isobars. (auth)

3656 BARYON ELASTIC WIDTHS FROM CROSSING-SYMMETRIC AMPLITUDES WITH REGGE BEHAVIOR. Virasoro, M. A. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 184: 1621-4(Aug. 25, 1969).

It is shown that the representations recently proposed that incorporate Regge behavior, crossing symmetry, and the "duality mechanism" make a definite prediction for the variation of the elastic widths of πN resonances lying on a Regge trajectory, which is in excellent agreement with experiment. (auth)

3657 COUPLING CONSTANTS AND SU(3) CLASSIFICATION OF THE Y_0^* (1405). Kim, Jae Kwan (Harvard Univ., Cambridge, Mass.); von Hippel, Frank. Contracts AFOSR F44620-68-C-0075; AT(930-1)-2752. Phys. Rev., 184: 1961-3(Aug. 25, 1969).

Values for the $Y_0^*(1405)$ couplings to the $\overline{K}$-N and π-Σ channels are presented. The relative sign is that appropriate to an SU(3) singlet, but the relative magnitude differs by almost a factor of 3 from the corresponding SU(3) prediction. (auth)

3658 FIXED-u FINITE-ENERGY SUM RULES FOR KN SCATTERING. Golab-Meyer, Z. (Jagiellonian Univ., Krakow); Kwiecinski, J. Acta Phys. Pol., 36: 227-35(Aug. 1969).

The possible fixed-u zero-moment FESR are discussed for KN scattering for amplitudes which correspond to pure $C = -1$ in the t-channel. It was found that those amplitudes whose asymptotic behavior is controlled by $I_u = 1$, $Y = 0$ (Σ type) trajectories satisfy superconvergence relations. The superconvergence relations do not hold for amplitudes asymptotically controlled by $I_u = 0$, $Y = 0$ (Λ type) trajectories. This fact indicates nonnegligible coupling of Λ_γ trajectory near $u = 0$. The FESR results for Λ_γ trajectory parameters were compared with the Barger fit of K^+p backward scattering. (auth)

3659 NONLINEAR PION–NUCLEON LAGRANGIANS. Finkelstein, R. (Univ. of California, Los Angeles). Physica, 44: 260-72(Sept. 15, 1969).

The group space of SU_2 is used as a representation space for

the pion field in order to obtain effective Lagrangians which have $SU_3 \times SU_2$ symmetry and are invariant under nonlinear transformations of the pion field. The method can be extended to other chiral groups. (auth)

3660 CROSS SECTIONS FOR MULTINEUTRAL CHANNELS IN HIGH-ENERGY PION–PROTON COLLISIONS. Bartke, J. (Inst. of Nuclear Research, Krakow). Acta Phys. Pol., 36: 223-5(Aug. 1969).

It is shown that the cross sections for multineutral channels can be calculated from the fitted-channel cross sections using the statistical isospin weights. (auth)

3661 SELECTION RULES FOR DIFFRACTION DISSOCIATION. Carlitz, R.; Frautschi, S.; Zweig, G. (California Inst. of Tech., Pasadena). Phys. Rev. Lett. 23: 1134-7(Nov. 10, 1969).

The concept that internal quantum numbers do not change in diffractive production is extended to the quantum numbers of the quark model. The resulting approximate selection rules are discussed and compared with the predictions of other models. (auth)

3662 DISTORTED-WAVE THEORY OF ONE MESON EXCHANGE REACTION. Giltinan, David Anthony. Cleveland, Case Western Reserve Univ., 1968. 137p.

Thesis.

A new distorted wave theory of the one meson exchange reaction is presented which has a better theoretical basis than previous treatments. The new method permits the evaluation of certain spin dependent effects neglected heretofore. The method is compared with the Sopkovich method for several reactions with the neglect of spin. The two methods converge only at very high energies. The $\pi + p \rightarrow \rho + p$ reaction at 2.0 GeV/c is analyzed with the new theory. The description of the ρ decay angular correlation is satisfactory but the description of the production angular distribution is only fair. A more extensive optical model parameter search should lead to improved results. (Disser. Abstr.)

3663 EXOTIC EXCHANGE OR KINEMATICAL REFLECTION. Berger, Edmond L. (Univ. of California, Berkeley). Phys. Rev. Lett. 23: 1139-43(Nov. 10, 1969).

Recently observed peripheral peaks in reactions where single-meson exchange is forbidden are explained as kinematical reflections. Experimental and theoretical implications are discussed. (auth)

3664 REGGE-EXCHANGE DRIVING FORCE AND DIRECT-CHANNEL RESONANCES IN $\pi\mathcal{N}$ CHARGE-EXCHANGE SCATTERING. Letessier, J.; Tounsi, A. (Institut de Physique Nucleaire, Paris). Nuovo Cim., 64A: 345-52(Nov. 21, 1969).

A Regge-type amplitude for $\pi\mathcal{N}$ charge exchange scattering is used as an input in an N/D partial-wave analysis. By taking into account only the ρ trajectory and unitarity, poles of various partial waves ($l = 0$ to 5) are found. Results are compared with the experimental data and with the Argand diagram analysis results. (auth)

3665 POLARIZATION IN K–NUCLEON SCATTERING. Johnson, P. W.; Kantor, P. B. (Case Western Reserve Univ., Cleveland). Nuovo Cim., 64A: 353-60(Nov. 21, 1969).

Constraints on the polarization due to s-channel unitarity are considered. It is found that polarizations may persist to all energies but that, if the amplitudes are exponentially peaked the spin flip peak must be at least half as wide as the nonflip peak. (auth)

3666 MULTI-CHANNEL DYNAMICS FOR THE $Y_1^*(1660)$ RESONANT STATE. Wong, T. C. (Chinese Univ. of Hong Kong). Nuovo Cim., 64A: 397-404(Nov. 21, 1969).

The channels BP, $Y_1^*(1405)P$ and BV are included in a dispersion calculation, in a simplified pole approximation, for the $\frac{3}{2}^-$ baryon resonances. The $Y_1^*(1660)$ is found to be consistent with the γ-octet assignment with a calculated total width of 46 MeV. (auth)

3667 $O_{3,1}$ SYMMETRY AND THE HIGH-ENERGY REACTION $\pi^+p \rightarrow \rho^0\mathcal{N}^*$. Raghavan, S.; Samiullah, M. (Osmania Univ., Hyderabad, India). Nuovo Cim., 64A: 434-8(Nov. 21, 1969).

An investigation of the high-energy reaction $\pi^+p \rightarrow \rho^0\mathcal{N}^*$ was made in the Delbourgo, Salam and Strathdee $O_{3,1}$ partial-wave expansion formalism. A good fit to the experimental data at 8 GeV/c was obtained assuming a j_0-mixing for the pion-trajectory. (auth)

3668 PSEUDOSCALAR–VECTOR MESON SCATTERING IN THE VENEZIANO MODEL. Capella, A.; Diu, B.; Kaplan, J. M.; Schiff, D. (Faculte des Sciences, Orsay, France). Nuovo Cim., 64A: 361-81(Nov. 21, 1969).

An extension of the Veneziano model to PS-V elastic scattering is presented, in which the mother Regge trajectory of each family considered has definite parity (both possibilities are considered: natural and unnatural parity dominance). The formulas obtained are then discussed from different points of view: factorization is not trivially satisfied in general, even for mother trajectories; the Adler self-consistency conditions are not automatically fulfilled, but one can impose them by relating the natural and unnatural parity contributions; as to superconvergence and finite-energy sum rules, they give rise to some difficulties, which, although not specific of the spin case, are increased in this situation. (auth)

3669 PION SCATTERING LENGTHS, THE VENEZIANO AMPLITUDE, AND ρ UNIVERSALITY. Mathur, V. S.; Olesen, P.; Rashid, M. A. (Univ. of Rochester, N. Y.). Nuovo Cim., 64A: 285-90(Nov. 21, 1969).

The Venziano amplitude, Adler's self-consistency condition, and universality of the ρ-coupling are shown to determine the S-wave scattering lengths for the process $\pi A \rightarrow \pi A$. A discussion is presented with reference to the current algebra result. (auth)

3670 AN ALTERNATIVE TO THE HYPOTHESIS OF AN S-WAVE π-K INTERACTION FROM AN ANALYSIS OF THE REACTION FROM AN ANALYSIS OF THE REACTION $K^+p \rightarrow \pi^+K^0p$ AT 785 MeV/c. Baracca, A. (Univ., Florence); Bergia, S. Nuovo Cim., 64A: 305-17(Nov. 21, 1969).

A unitarized model taking into account $P_{\frac{1}{2}}$ and $S_{\frac{1}{2}}$ π-$\mathcal{N}$ final-state interactions is considered in order to interpret the main features of the reaction $K^+p \rightarrow \pi^+K^0p$ at 785 MeV/c (well below the threshold for K^* production). A characteristic feature of the experimental results is a linear term in the π-$\mathcal{N}$ decay angular distribution; the sign of this term is not fixed in the model; a qualitative agreement with experiments can be reached for one of the choices. (auth)

3671 A REGGE POLE + CUT MODEL FOR TWO-BODY REACTIONS DOMINATED BY ρ EXCHANGE. Kajantie, K.; Ruuskanen, P. V. (Univ. of Helsinki). Nucl. Phys., B13: 437-50(1969).

The reactions $\pi N \rightarrow \omega N$ and $\pi N \rightarrow \omega\Delta$ are analyzed in terms of a model involving (a) reggeized ρ exchange (b) the assumption that the ρ coupling in the baryon vertex changes the baryon helicity by one and that the $N\rho\Delta$ coupling is of dipole type (c) the cuts associated with the ρ pole through absorption. Since the reactions $\pi N \rightarrow \pi^0 n$ and $\pi N \rightarrow \pi\Delta$ also can be described by this model it is proposed that it is valid for all two-body reactions dominated by ρ exchange. (auth)

3672 ρ + R REGGE-POLE MODEL FOR ISOBAR PRODUCTION. Krammer, M. (Deutsches Elektronen-Synchrotron, Hamburg); Maor, U. Nucl. Phys., B13: 651-61(1969).

The reactions $\pi^+p \rightarrow \pi^0\Delta^{++}$, $\pi^+p \rightarrow \eta\Delta^{++}$ and $K^+p \rightarrow K^0\Delta^{++}$ are analyzed in a ρ + R Regge-pole model. Kinematical singularities and threshold (pseudothreshold) conditions are incorporated in the parametrization. The polarization data are examined and their implications with respect to the dynamical structure of the helicity amplitudes are inferred. SU(3) symmetry and exchange degeneracy are applied in order to minimize the number of free parameters. A satisfactory description of these isobar production processes is obtained. (auth)

3673 EXCHANGE DEGENERACY, DUALITY, AND REGGE CUTS. Michael, C. (Argonne National Lab., Ill.). Nucl. Phys., B13: 644-50(1969).

Duality leads to exchange degeneracy for Regge trajectories, and empirical evidence is presented that such a degenerate scheme is not satisfied. A substantial improvement results from the inclusion of Regge cut corrections. These corrections are discussed, separating for clarity the P and non-P contributions to the cut. Application is made to pairs of line reversed reactions such as $\bar{K}N$ and $K\bar{N}$ charge exchange, and $\pi^+p \rightarrow K^+\Sigma^+$ and $K^-p \rightarrow \pi^-\Sigma^+$. (auth)

3674 APPLICATION OF THE GENERALIZED VENEZIANO MODEL TO $K^-p \rightarrow \pi^-\pi^+\Lambda$. Petersson, B.; Toernqvist, N. A. (CERN, Geneva). Nucl. Phys., B13: 629-43(1969).

The five-point function in the generalized Veneziano model is used for a phenomenological description of the process $K^-p \rightarrow \pi^-\pi^+\Lambda$. With essentially only one free parameter this model reproduces the main features of the experimental data including both resonance production and Regge behavior, in the energy range 3 to 10 GeV/c. (auth)

3675 TOWARDS A NEW ABSORPTION MODEL FOR HADRON COLLISIONS. Dar, A. (Technion-Israel Inst. of Tech., Haifa); Watts, T. L.; Weisskopf, Victor F. Nucl. Phys., B13: 477-502(1969).

The cross sections for meson-exchange reactions induced by pions are calculated with a method which assumes that, for high angular momentum or high impact parameter b, the Born approximation is valid and that for small impact parameter b the reaction amplitude vanishes. For treating intermediate values b a step-

function $\eta(b)$ is introduced which goes from zero to one at $b \sim R$ within an interval d. Both R and d are slowly varying functions of s, which are assumed to be the same for all pion-induced reactions. The expressions for the Born approximation are completely determined by the coupling constants of the exchange particles with the reaction partners. For reactions in which the coupling constants are given, the only unknown input are the values of R and d. The latter ones are determined by fitting the pion charge-exchange reaction at several energies. The main features of many other pion-exchange reactions are then well reproduced by this method. (auth)

3676 PARTIAL WAVES AND EXCHANGE MODELS IN THE REACTIONS $\pi N \to \pi\pi N$. Bijtebier, J. (Univ., Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 55: 311-51(1969). (In French).

A theoretical framework to be used in the analysis of the experimental data for the reaction $\pi N \to \pi\pi N$ is presented in terms of partial wave amplitudes and amplitudes corresponding to peripheral production of N^* and ρ. The amplitudes are expressed in terms of Pauli spinors and matrices. The final amplitude contains adjustable parameters corresponding to various admixtures of the partial wave and exchange amplitudes. The presence of Minami-type ambiguities in $\pi N \to \pi\pi N$ partial wave analysis is pointed out and finally the partial wave expansion of exchange amplitudes is developed. (auth)

3677 BACKWARD SCATTERING IN REACTIONS $\pi^- p \to \Sigma^- K^+(\Lambda^0 K^0)$ AND THE INTERFERENCE MODEL. Ter-Ovanesov, E. F. (Leningrad Pedagogical Inst.). Yadern. Fiz.; 10: 616-18 (Sept. 1969). (In Russian).

Backward scattering in reactions $\pi^- p \to \Sigma^- K^+(\Lambda^0 K^0)$ is considered in the framework of the interference model. An agreement with the measured results at intermediate energies is obtained. (auth)

3678 RECENT APPLICATIONS OF KN FORWARD DISPERSION RELATIONS AND SUM RULES. Queen, N. M. (Univ. of Birmingham, Eng.); Restignoli, M.; Violini, G. Fortschr. Phys., 17: 467-516(1969).

Recent applications of kaon-nucleon forward dispersion relations, superconvergence relations, finite energy sum rules, derivative sum rules, and the Adler-Weisberger sum rule are reviewed. These dispersion relations and sum rules have been used for the determination of the $KN\Lambda$ and $KN\Sigma$ coupling constants, the phases of the kaon-nucleon forward scattering amplitudes, and the Regge pole parameters, and have allowed tests of the PCAC hypothesis for strangeness-changing currents. They also provide important constraints which help to resolve ambiguities in the phenomenological analysis of the scattering data. A critical comparison of various methods which have been proposed is given, the theoretical predictions are compared with experiment when possible, and our present knowledge of the kaon-nucleon interaction parameters is summarized. Some new results are presented. (auth)

3679 CROSSOVER AND MOVING BRANCH POINTS. Kaidalov, A. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 10: 619-26(Sep 1969). (In Russian).

It is shown that the explanation of the "crossover" (change of the sign of difference between the differential cross sections pp and $\bar{p}p$ as well as of K^+p and K^-p scattering) in terms of the Regge pole model meets with serious difficulties. The account of branchings in j-plane allows one to describe naturally this phenomenon. The contribution from the ωP branching is estimated. (auth)

3680 VENEZIANO πN AMPLITUDE WITH PCAC AND THE ADLER-WEISBERGER CONDITIONS. Namyslowski, J.; Swiecki, M. (Warsaw Univ.). Nuovo Cim., 64A: 555-60(Dec. 1, 1969).

Assuming degeneracy of the $N(\frac{1}{2}^+)$ with $N(\frac{3}{2}^-)$, and $\Delta(\frac{3}{2}^+)$ with $N(\frac{1}{2}^-)$ trajectories, a Veneziano-type model is proposed for the πN amplitude with PCAC and Adler-Weisberger conditions satisfied, and with the correct isospin structure built in. The πN scattering lengths, low-energy phase shifts, the elastic widths of resonances, and the high-energy forward scattering are found in qualitative agreement with experiment. (auth)

3681 QUARK MODEL, PARTIAL SYMMETRY, AND A UNIFIED SCHEME FOR PBB_L AND VBB_L COUPLINGS. Mitra, A. N. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., 64A: 603-17(Dec. 1, 1969).

The general ideas of the quark model used previously for the construction of couplings of baryons (B) and their resonances (B_L) to pseudoscalar (P) mesons are extended to include their couplings also to vector mesons (V) through Schwinger's partial-symmetry method which provides a simple means of relating the VBB_L to the PBB_L vertices. The latter in turn are provided by a semi-relativistic model of broken $SU_6 \times O_3$ recently proposed by the author through an explicit ansatz for the form factors on the relevant masses, which enables a single parameter to describe an entire supermultiplet transition. The model is applied to the $N\pi\pi$ modes of several N- and Δ-type resonances, via the $N\rho$ mechanism. The results suggest that, analogously to the $\omega \to 3\pi$ case, an $N\rho$ intermediate state, even when energetically forbidden, could still provide an important alternative to the $\Delta\pi$ mechanism for $N\pi\pi$ modes. (auth)

3682 PARAQUARKS OF SPIN ½. Parashar, D. N. (Univ. of Delhi. Atma Ram Sanatan Dharma Coll., New Delhi). Nuovo Cim., 64A: 618-26(Dec. 1, 1969).

A nonrelativistic quark model involving s-wave quarks of spin ½ is proposed for baryons. Assuming such quarks to obey parastatistics some static properties like magnetic moments and mass differences of baryons are studied in detail. It is found that most of the experimentally tested spin-½ quark results follow from this model. The model, however, predicts the M_1-transition magnetic moment for the process $\Delta^+ \to P\gamma$ to be 1.32 $(2\sqrt{2}/3)\mu_p$ in excellent agreement with the experimental value (1.28 ± 0.02) $(2\sqrt{2}/3)\mu_p$, the corresponding spin-½ quark value being $(2\sqrt{2}/3)\mu_p$. On the other hand, the proton-neutron magnetic moment ratio μ_p/μ_N is predicted to be $-3/4$ as against the spin-½ quark value $-3/2$, the former being in disagreement with the experimental value -1.46. (auth)

3683 REGULARITY OF PARTICLE PRODUCTION IN HADRON COLLISIONS AND THE STRUCTURE OF THE NUCLEON. Wang, C. P. (Case Western Reserve Univ., Cleveland). Nuovo Cim., 64A: 546-54(Dec. 1, 1969).

The multiplicity distribution for charged secondaries emitted from pp, π^+p, pn, π^+n, nn, K^+p and $\bar{p}p$ collisions was found to define a single set of curves which can be expressed by a universal set of "multiplicity distribution functions" constructed from Poisson terms when conservation laws are suitably incorporated. The AK^0 accompanying the pions produced in π^-p collision, and the neutrals (mostly π^0) produced in π^-p inelastic charge-exchange reactions were also found to follow the same distribution. The distribution functions so obtained contain no adjustable parameter and fit well the NN cosmic-ray jet data. The Poissonian characteristic of the multiplicity regularity found points immediately to the existence of a number of nearly independent production regions or "cells" inside the nucleon (and other hadrons), and the fireball. (auth)

3684 CURRENT ALGEBRA AND P-WAVE PION–NUCLEON SCATTERING. Hengeltraub, A.; Vasconcelos, J. (Univ., Turin). Nuovo Cim., 64A: 649-57(Dec. 1, 1969).

P-wave π-N scattering is discussed using a technique similar to that used in current algebra. Sum rules obtained from the commutators $[Q^A_\alpha, Q^A_\beta] = i\epsilon_{\alpha\beta\gamma} Q^V_\gamma$ and $[D^A_\alpha(x,t), D^A_\beta(0,t)] = 0$ are combined together. Analogously the combination of the two sum rules obtained from the commutators $[Q^A_\alpha, D^A_\beta] = 0$ and $[D^A_\alpha(x,t), D^A_\beta(0,t)] = 0$ are considered. These two combined sum rules are saturated with the contribution of the pion, nucleon and $N^*(1236)$ resonance, neglecting all other possible states. Use is made of the fitted values of the p-wave scattering lengths and of the s-wave effective range to determine the pion-nucleon-$N^*(1236)$ coupling constant. The two results obtained are in agreement with each other and with the known value. (auth)

3685 INELASTIC RESONANCES WITH THE REPULSIVE BACKGROUND. Kinoshita, Yukiko (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto), 42: 629-40(Sept. 1969).

The behavior of the πN-S_{31} amplitude on the Argand diagram is reproduced up to ~1800 MeV quite well by the two-channel model consisting of the πN and ρN channels under the following dynamical situation. The resonance in the ρN channel appears in the πN channel by a weak channel coupling, where the πN pure elastic amplitude works as the repulsive background. Another two-channel model consisting of the πN and $\pi\Delta$ is also able to reproduce the πN-S_{31} amplitude qualitatively by the similar dynamical situation stated above. The πN-P_{31} and P_{13} amplitudes which have a structure similar to the S_{31}, can also be understood as inelastic resonances with the repulsive background. (auth)

3686 CURRENT x CURRENT STRUCTURE OF STRONG INTERACTIONS IN CHIRAL U(2) x U(2) SYMMETRY. Ohta, Tadayuki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 746-8(Sept. 1969).

It is shown that the interaction terms of the chiral invariant Lagrangians of meson (π)–nucleon and proton–neutron systems are mainly of a current × current type. The chiral U(2) × U(2) symmetry is used. (J.F.P.)

3687 F_K/F_π AND BROKEN SU(3) ⊗ SU(3) CHIRAL DYNAMICS. Noda, Hujio (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 730-2(Sept. 1969).

The problem of F_K/F_π is discussed within the framework of chiral dynamics by introducing a symmetry breaking in a consistent manner. The expression $F_K/F_\pi = m_{K^*}/m_\rho$ and several other relations are found. (J.F.P.)

3688 ARBITRARINESS IN OPTICAL MODELS OF HIGH-ENERGY PROCESSES. Yoshimura, Tetz (Univ. of Adelaide). Progr. Theor. Phys. (Kyoto), 42: 728-30(Sept. 1969).

Arbitrariness in optical models for high-energy interactions is investigated using the Byers–Yang model for meson (π)–nucleon scattering as an example. This model expresses relations between elastic and charge exchange amplitudes without spin flip in the impact parameter representation. It is concluded that it cannot be determined whether these amplitude relations hold in a good approximation, and forms of forward peaks and definitions of effective radii cannot be determined. For similar reasons it is concluded that it is impossible to determine from the experimental data whether the relations implied by the optical models hold better for the helicity amplitudes rather than the spin amplitudes or vice versa. (J.F.P.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 3589, 3683, and 3792.

3689 (TID–25249) SECOND-ORDER CORRECTION TO THE Λ BINDING ENERGY IN NUCLEAR MATTER. Ram, B.; Williams, W. (New Mexico State Univ., Las Cruces. Dept. of Physics). [1969]. 7p. Dep. CFSTI.

The second-order correction to the Λ binding energy in nuclear matter evaluated in the independent pair approximation is found to be small. (auth)

3690 A MODEL FOR PION PRODUCTION IN PROTON–PROTON SCATTERING. Zipfel, George Gustave Jr. Ann Arbor, Mich., Univ. of Michigan, 1968. 52p.

Thesis.

A theory of pion production in proton–proton collisions is presented. In it the pions are assumed to be produced in a coherent state whose dynamics are governed by a classical Langrangian. The model pictures a proton as a core surrounded by a cloud of pions and a vector field. The production of pions is due to interaction between the pion cloud of one proton and the vector field of the other proton. The observed suppression of pion production at 90° in the proton–proton center of mass system is explained as a rescattering effect. (Diss. Abstr. Int., B)

3691 COMPARISON OF FINITELY AND INFINITELY COMPOSITE MODELS FOR HIGH-ENERGY PROTON–PROTON SCATTERING. Harrington, David R.; Pagnamenta, Antonio (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., 184: 1908-14(Aug. 25, 1969).

The Glauber theory of high-energy scattering was extended to the collision of two clusters with N = 2, 3, 4, and infinitely many constituents each. For the special case of Gaussian scattering amplitudes and form factors, a convenient matrix formula is derived which reduces the evaluation of the multiple Gaussian integrals to the diagonalization of a symmetric matrix which can be read off from each graph and allows complete summation (by computer) of the multiple-scattering series. The convergence of the Glauber series is investigated and found to be excellent for most of the parameter values of interest. These results were derived with the intention of comparing the hadronic differential cross sections in different quark-type models. It is found that all the models discussed lead to excellent fits to the experimental proton-proton differential cross section. While the N = 3 quark model or the N = ∞ droplet model may be preferred on other grounds, it is found that the limited freedom one has in deciding to what degree the shape of the scattering amplitude is due to the form factors and to what degree to the elementary scattering amplitudes makes it impossible to differentiate between the two models on the basis of the structure of the differential cross section alone. (auth)

3692 REGGE-POLE MODEL FOR INVARIANT FUNCTIONS. II. THE CHARGE-EXCHANGE PROCESSES $pn \to np$ AND $p\bar{p} \to n\bar{n}$. Geicke, J.; Muetter, K. H. (Freie Univ., Berlin). Phys. Rev., 184: 1551-5(Aug. 25, 1969).

The structure of the $pn \to np$ and $p\bar{p} \to n\bar{n}$ charge-exchange data is described by three Regge-type poles in two invariant functions. (auth)

3693 CORRECTIONS TO THE GLAUBER MODEL OF HIGH-ENERGY SCATTERING. Bhasin, V. S.; Varma, V. S. (Univ. of Delhi). Phys. Rev., 184: 1338-42(Aug. 25, 1969).

The modifications to the Glauber model are studied when the principal-value part of the double-scattering term is also taken into account. An estimate of the importance of this term is made by studying its effect first on the values of the ratios of the real to imaginary parts α_{pp} and α_{pn} of the p-p and n-p amplitudes, respectively, and second on the cross-section defect. It is observed that this principal-value term makes its most significant contribution in the region of interference between single and double scattering and can therefore influence the values of α_{pp} and α_{pn} obtained from the best fits to the proton-deuteron scattering data. (auth)

3694 CONCERNING THE n-p SCATTERING CROSS SECTION AT 24 MeV. Breit, G.; Lucas, J.; Tischler, M. (State Univ. of New York, Buffalo). Phys. Rev., 184: 1668-72(Aug. 25, 1969).

Recent measurements of the n-p scattering cross section at 24 MeV are compared with the later Yale phenomenological multi-energy phase-parameter analysis, $(Y\text{-}IV)_{pp+np}$. Good agreement is found for both relative and absolute values. Lack of symmetry in the angular distribution of the differential cross section $\sigma(\theta)$, expected from the Y-IV phases, fits in with the total cross section and the new relative $\sigma(\theta)$ measurements. The newer data support the YLAN3M, YLAN4M, Y-IV type of phase-parameter set at energies near 25 MeV, with the rather large absolute value of the negative $^1P_1$ phase shift K_1 and a positive value of the $^3S_1$-$^3D_1$ coupling parameter ρ_1. No claim is made that there exist no other phase-parameter sets acceptable on the basis of scattering data alone; but since the positive sign of ρ_1 fits in naturally with the positive sign of the quadrupole moment of the deuteron, and since the low-energy anchor of K_1 has been obtained by means of a reasonable potential, the new measurements do not indicate a need for discarding these elementary considerations as approximate guides in phase-parameter analysis. The relative importance of contributions of a few phase parameters is pointed out, with special reference to the fore-aft asymmetry of the angular distribution expected from the Y-IV phase parameters. (auth)

3695 HIGH-ENERGY pp ELASTIC DIFFRACTION SCATTERING FROM INELASTIC STATES. Gundzik, M. G. (Argonne National Lab., Ill.). Phys. Rev., 184: 1537-50(Aug. 25, 1969).

Small-angle high-energy elastic proton-proton scattering, i.e., the Pomeranchukon contribution, is determined through unitarity in terms of a model for the inelastic intermediate states. These are represented by two contributions: (i) quasielastic production of free pions, described in terms of a c-number source current $\beta(k)$ for the pions, assuming factorization of the production amplitude into a part proportional to the elastic pp amplitude times a part depending on $\beta(k)$ and the proton momenta; (ii) peripheral production of a spectrum of N* states by the longest range possible force–single-pion exchange. The combination of these two contributions leads to an inhomogeneous integral equation for the elastic amplitude $F(s,\theta)$, which becomes the condition for elastic unitarity when no pions are produced. The integral equation for $F(s,\theta)$ is simplified under Fourier–Bessel transformation to its impact-parameter representation when the high-energy, small-angle limit is taken. The resulting nonlinear, inhomogeneous integral equation is solved numerically, and used to determine the elastic differential cross section $d\sigma/dt$. Normalizing the amplitude to the total cross section σ_{tot} in the forward direction, it is found that the iterative solution can be considered to depend on σ_{tot}, the elastic cross section σ_{el}, a parameter α determined by $\bar{n}(P,\theta)$, and a free parameter λ that parametrizes the phase of $\beta(k)$. With experimentally determined values of σ_{tot}, σ_{el}, and α, the parameter λ can be fitted to give $d\sigma/dt$ in agreement with elastic data at 25 GeV/c for t in the range $0 \le -t \le 1.0$ $(GeV/c)^2$. (L.B.S.)

3696 SOFT PION PRODUCTION IN NUCLEON–NUCLEON COLLISIONS. Grant, C. T.; Schillaci, M. E.; Silbar, R. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 184: 1737-9 (Aug. 25, 1969).

The emission of soft pions in nucleon-nucleon collisions is studied for lab energies in the range 500 to 800 MeV. Following the prescription of the Adler–Dothan theorem, the dominant contribution is considered to arise from processes involving emission from external nucleon lines only. The amplitudes are calculated in the helicity representation, the invariant functions for the nucleon-nucleon scattering being obtained from phase shifts. Cross sections for $pp \to np\pi^+$ are given in some detail. (auth)

3697 BOOTSTRAP PREDICTION FOR THE WIDE-ANGLE PROTON–PROTON SCATTERING AMPLITUDE. Harte, John (Yale Univ., New Haven); Ong, Kwok Maw. Phys. Rev., 184: 1948-50(Aug. 25, 1969).

High-energy, wide-angle proton-proton scattering data are compared to the predicted asymptotic, crossing-symmetric scattering amplitude obtained in an off-mass-shell, unitary bootstrap model.

The predicted amplitude is of the form of a sum of the squares of the nucleon form factor in all three channels. Both the fixed-angle and fixed-energy data are well fitted by this asymptotic formula. (auth)

3698 THEORETICAL NEUTRON–NUCLEUS TOTAL CROSS-SECTIONS AT HIGH ENERGY. Rudin, R. A. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Lett., 30B: 357-8 (Oct. 27, 1969).

Total cross sections for scattering of 10 GeV/c neutrons from nuclei are calculated in the Glauber model. Results are in good agreement with recent measurements, provided the nuclear radii are taken from electron-nucleus scattering measurements. (auth)

3699 1p SHELL HYPERNUCLEI DEFORMATION AND MAJORANA EXCHANGE BINDING ENERGY EFFECTS. Ho, T. H.; Volkov, A. B. (McMaster Univ., Hamilton, Ont.). Phys. Lett., 30B: 303-5(Oct. 27, 1969).

The Λ binding energy is reduced in 1p shell hypernuclei by taking deformation into account. The binding also can be reduced by increasing the Majorana exchange component of the ΛN force but this reduces the deformation effect. (auth)

3700 ANALYTIC EXPRESSIONS FOR THE PHASE SHIFTS FOR SHORT-RANGE POTENTIALS. Almstroem, H. (Royal Inst. of Tech., Stockholm). Nuovo Cim., 64A: 318-21(Nov. 21, 1969).

When calculating the phase shifts by perturbation methods one arrives at multiple integrals. However it is shown that with the potential $V(r) = (1/r)\int_m^M \sigma(a) \exp[-ar]da$, $m > 0$, $M < \infty$, $\sigma(a)$ a generalized function, one arrives at an equation which can be transformed into an infinite linear system of equations. The solution to the finite system gives the approximate phase shifts in analytic form in all the parameters. (auth)

3701 THE ANALYSIS OF THE REACTION $pp \rightarrow pp\pi^+\pi^+\pi^-\pi^-$ AT AN INCIDENT MOMENTUM OF 28.5 GeV/c. Kenyon, I. R. (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys., B13: 255-73(1969).

Some features of the reaction $pp \rightarrow pp\pi^+\pi^+\pi^-\pi^-$ are discussed and models of production mechanisms compared with the data. Excellent agreement is found with the Reggeized multiperipheral model, when this is modified to account for the observed strong $\Delta(1236)$ and $\rho(760)$ production. Baryon exchange is found to make an important contribution to the cross section. On the other hand the multiperipheral mechanism appears to suppress the importance of diffraction dissociation which is not in evidence in our reaction. Fits to a modified bremsstrahlung model are not very satisfactory but reveal the interrelation of the proton shape to the exchange mechanisms. (auth)

3702 PHASE-SHIFT ANALYSIS OF p–p AND n–p ELASTIC SCATTERING AT 735 MeV. Bilenkaya, S. I. (Joint Inst. for Nuclear Research, Dubna, USSR); Cozzika, G.; Lehar, F.; Janout, Z. Nucl. Phys., B13: 375-84(1969).

Phase-shift analysis of the elastic N-N scattering at 735 MeV was performed taking $l_{max} = 4$. It was supposed that the pion production gives a main contribution in the P, D, and F states. The search for the solutions was performed only for the isospin $T = 1$. Ten solutions with the negative sign of the $^1S_0$ phase shift were found in the interval $\chi^2 \leq 1.5\ \chi^2$. All these solutions were used as initial conditions for the specification of the simultaneous pp and np phase-shift analysis. The values of phase shifts are given in the tables and the most important angular dependences of experimental quantities for the four first solutions are shown in the graphs. The new statistical criterion was performed for the discrimination between the phase-shift sets. Using this criterion, the whole number of solutions was reduced to 4, from which only two for $^1S_0 < 0$. (auth)

3703 USE OF DATA ON π MESON PRODUCTION TO DETERMINE ABSORPTION COEFFICIENTS OF ELASTIC pp SCATTERING AT 650 TO 660 MeV. Vovchenko, V. G.; Zhdanov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern Fiz.; 10: 637-43(Sept. 1969). (In Russian).

Inelastic pp scattering is analyzed on the basis of the resonance model of meson production proposed by Mandelstam. Parameters of the resonance model were re-estimated using the most essential experimental data on the reactions of π^+ and π^0 meson production in pp collisions at 660 MeV, and absorption coefficients (imaginary parts of phase shifts) for the states in which the meson production is taken into account, are obtained. The absorption coefficients calculated according to the resonance model and to the peripheral model of one-pion exchange are compared with those obtained from the phase analysis. The peripheral model and some variants of the phase analysis in which the information on π meson production is used not very carefully, give the absorption coefficients not corresponding to the cross section of inelastic pp scattering at 660 MeV. (auth)

3704 ON IMITATION OF ISOBARS N*(1236) AND N*(1400 TO 1470) BY TRIANGLE FEYNMAN GRAPH IN REACTIONS $p + p \rightarrow p + N + \pi$ AND $\pi + p \rightarrow p + \pi + \pi$. Dubovoi, E. I. (Radiotechnical Inst., Moscow). Yadern. Fiz.; 10: 611-15(Sept. 1969). (In Russian).

It is shown that "bumps" in differential cross section of the reaction $p + p \rightarrow p + N + \pi$ which are usually interpreted as the resonances N*(1236) and N*(1400 to 1470) can be explained by the contribution to the amplitude of the reaction of triangle graphs with stable virtual particles. (auth)

3705 COMMUTATION OF AXIAL CHARGE WITH AXIAL DIVERGENCE. Abdel-Rahman, A-M. M. (Univ. of Liverpool). Progr. Theor. Phys. (Kyoto), 42: 750-2(Sept. 1969).

A sum rule is considered which arises when the commutator $[\bar{Q}^{I+\frac{1}{2}}, \bar{D}^{I+\frac{1}{2}}] = 0$, where $\bar{Q}^{I+\frac{1}{2}}$, $\bar{D}^{I+\frac{1}{2}}$ are the strangeness-changing axial charge and the strangeness-conserving axial divergence, respectively, is taken between physical Σ^- and proton states. (J.F.P.)

3706 EFFECT OF CORRELATIONS ON HIGH-ENERGY PROCESSES USING NUCLEAR TARGETS. Moniz, E. J.; Dixon, G. D. (Stanford Univ., Calif.). Phys. Lett., 30B: 393-6(Nov. 10, 1969).

The two-body correlation function was computed for nuclear matter, and the effect of correlations on high-energy processes was investigated using nuclear targets. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 3774.

3707 (JINR–E2-4716) SECOND ORDER INFINITE COMPONENT WAVE EQUATION. Huszar, M.; Smorodinskii, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 11p. Dep. CFSTI (U. S. Sales Only).

As a straightforward generalization of the Majorana equation an infinite-component second-order wave equation is investigated with the aid of the noninvariance group U(3,1). The mass spectrum obtained is degenerate in the sense that equation describes several particles with integer spin belonging to the same mass value. Relation to the three-dimensional oscillator is briefly discussed. (auth)

3708 (JINR–P2-4684) TRIPLET REPRESENTATIONS OF D-FUNCTIONS. Mal'tsev, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 6p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Triplet representations of D-functions are obtained which are a part of the expression for a statistical weight of the many-particle state. (auth)

3709 NONLINEAR REALIZATIONS. I. THE ROLE OF GOLDSTONE BOSONS. Salam, Abdus; Strathdee, J. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 184: 1750-9(Aug. 25, 1969).

A method, based upon anologies with the Wigner boost technique, is presented for setting up the nonlinear realizations of any continuous symmetry group. It is argued that such realizations are relevant to and useful in the treatment of cases of spontaneous symmetry breakdown. (auth)

3710 NONLINEAR REALIZATIONS. II. CONFORMAL SYMMETRY. Salam, Abdus; Strathdee, J. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 184: 1760-8(Aug. 25, 1969).

Use is made of the formalism of nonlinear realizations to treat the spontaneous violation of conformal symmetry. The associated "Goldstone" particles, which are characterized by a four-vector and a scalar field, are unusual in that they possess mass. (auth)

3711 PRESYMMETRY. II. Ekstein, H. (Argonne National Lab., Ill.). Phys. Rev., 184: 1315-37(Aug. 25, 1969).

The association between laboratory procedures and self-adjoint operators (observables), usually implicit and allusive, is made explicit by the introduction of two collections of nonmathematical objects; the observation procedures and the state-preparing procedures. By a process of idealization and extrapolation from empirical facts, these two collections are turned into mathematical sets ("hardware spaces") with the structure of a star algebra

O and a convex linear set S, respectively. There is a many-one mapping from O into the space U of observables (the operators on Hilbert space), and physical laws or solutions of equations of motion are embodied in the mapping Φ: O → U. Certain material motions of observation instruments and state-preparing instruments induce automorphisms of the hardware spaces but in general, not automorphisms of U. An extension of space-time invariance theory to accelerations $[x \to x + \Sigma_2^n (n!)^{-1} r_n t^n]$, to external symmetry-breaking fields, and to subsystems under the influence of other subsystems becomes possible. The main results are a derivation of Newton's second law and of the gravitational equivalence principle for nonrelativistic quantum mechanics from invariance and causality principles. (auth)

3712 REPRESENTATION FUNCTIONS FOR SU(3). Mickelsson, Jouko (Univ. of Helsinki). J. Math. Phys. (N. Y.), 10: 1968-70(Oct. 1969).

"Euler" decomposition for SU(3) was found by analytic continuation from the "Euler" decomposition of SU(2,1), which is based on the factorization $SU(2,1) = SU(2) \times A_u \times A \times SU(2)$ derived by Hilton [$A_u \sim U(1)$ and A is one-parameter subgroup of the V-spin subgroup]. For the degenerate case the SU(3) representation functions can be found by transforming to a new basis where the V-spin subgroup is diagonal. The result is a sum of products, each product containing two D-functions, one d-function, and an exponential function exp [imχ]. As is well known, every representation D(p,q) can be reduced from the direct product D(p,0) × D(q,q). The nondegenerate representation functions can then be directly written down using the SU(3) CG coefficients, which are relatively simple for the above mentioned case. (auth)

3713 REPRESENTATION THEORY OF SO(4,1) AND E(3,1): AN EXPLICIT SPINOR CALCULUS. Holman III, Wayne J. (Univ. of Miami, Coral Gables, Florida). Contract Nos. NASA NGR 10-007-010; AF AFOSR 1268-67. J. Math. Phys. (N. Y.), 10: 1888-96(Oct. 1969).

The explicit spinor basis states for the irreducible unitary representations of the spinor covering group of the de Sitter group SO(4,1) are obtained by analytic continuation from those of the compact group Sp(4). Some features of the contraction of these basis states to those of the Poincaré group are discussed; the explicit asymptotic form of the basis state of a continuous representation of SO(4,1) in the limit of the contraction to a basis state of a finite-mass discrete-spin representation of E(3,1) is investigated. (auth)

3714 FINITE TRANSFORMATIONS AND BASIS STATES OF SU(n). Holland, Douglas Francis (Northern Arizona Univ., Flagstaff). J. Math. Phys. (N. Y.), 10: 1903-5(Oct. 1969).

A convenient parameterization for finite transformations of SU(n) is developed which explicitly exhibits the special unitary subgroups. This is also used to parameterize the defining space. Higher-dimensional representations are discussed. The question of which representations carry the trivial representation of SU(n − 1) is considered, as well as the parameterization of these states. Application is made to the transformations and basis states of SU(3). (auth)

3715 POINCARE GENERATORS, UNITARY TRANSFORMATIONS, AND HELICITY REPRESENTATIONS. Beckers, J.; Pirotte, C. (Univ., Liege). Nuovo Cim., 64A: 439-46(Nov. 21, 1969).

Coester and Chakrabarti have proposed independently unitary transformations diagonalizing the helicity operator and connecting the [m,s] and [0,s] I.U.R. of $P_+^\uparrow$ through the limiting process m → 0. The unitary transformation giving the explicit equivalence of these contributions is calculated. When used for defining a helicity basis for [m,s] I.U.R., the Chakrabarti transformation is found to be convenient to obtain the associated transformation laws under infinitesimal Lorentz transformations. The corresponding transformation laws for m = 0 follow directly in agreement with Fronsdal's results. (auth)

3716 SPIN ALGEBRAS AND THE POINCARE GROUP. Braathen, H. J. (Univ. of Oslo. Case Western Reserve Univ., Cleveland); Foldy, L. L. Nucl. Phys., B13: 511-36(1969).

The spin of an elementary particle is characterized in terms of the generators of the Poincaré group. A spin algebra, related to the canonical spin algebra, is constructed giving a preferred treatment to one particular space direction chosen to be that of the z-axis. The helicity operator is an element of the spin algebra, a second is defined so that it commutes with the generator of Lorentz transformations along the z-axis. A basis for a representation space is chosen in which the operators for space translations and this new spin algebra element are diagonal. The generators of the Poincaré group are represented in this basis. The basis is proven to be equivalent to the states defined by Kotánski in terms of which the spin crossing matrices are diagonal. The phases for this basis are introduced without using a singular rest state. The rest state in turn is defined from the general state by a unitary transformation. The problem of the azimuthal angles in scattering amplitudes is discussed and likewise the role that these angles play in the representation of the discrete elements of the Poincaré group. (auth)

3717 HELICITY AND UNITARY REPRESENTATIONS OF THE LORENTZ GROUP. Kuznetsov, G. I.; Liberman, M. A.; Makarov, A. A.; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 10: 644-56(Sep 1969). (In Russian).

Unitarity representations of the Lorentz group, realized on the functions on the cone $k^2 = 0$, are constructed. Helicity functions of the point on hyperboloid $u^2 = 1$ representing a basis of the unitary irreducible representations of the Lorentz group are constructed, using the integral transformation from the cone to the hyperboloid. (auth)

3718 SPACE PARITY CONSERVATION IN NUCLEAR REACTIONS ^{3}He(d,p)^{4}He AND ^{2}H(d,p)^{3}H. Ad'yasevich, B. P.; Antonenko, V. G. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 10: 485-7(Sep 1969). (In Russian).

The reactions ^{3}He(d,p)^{4}He and ^{2}H(d,p)^{3}H were excited by a polarized beam of deuterons with energy 450 and 150 keV, respectively. Space parity violation in these reactions can be detected from the asymmetry of the proton emission along and opposite to the direction of deuteron polarization vector along the beam axis. Results of measurements have shown that this asymmetry is absent up to $5(10)^{-4}$. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 3958.

3719 (COO-264-523) FORM FACTOR MODELS AND CHIRAL SYMMETRY. Frampton, P. H. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). [1969]. Contract AT(11-1)-264. 11p. (EFI-69-90). Dep. CFSTI.

Simple models for the vector and axial-vector form factors are examined from the point of view of their consistency with the beta function model and with the chiral properties of the vector and axial vector currents. In an infinite class of solutions for these two form factors the asymptotic power behaviors are not determined absolutely but are related through a quantization rule for the Regge trajectory intercepts. Predictions for the vector and axial-vector form factors of the nucleon are made. (auth)

3720 REPEATED EXPERIMENT ON DETECTION OF WEAK NUCLEON–NUCLEON INTERACTION. Abov, Yu. G.; Krupchitskii, P. A.; Bulgakov, M. I.; Ermakov, O. I.; Karpikhin, I. L. Inst. of Theoretical Physics, Moscow). Yadern. Fiz.; 10: 558-68 (Sep 1969). (In Russian).

The asymmetry coefficient in the angular distribution of γ quanta emitted by ^{114*}Cd when irradiating Cd by polarized neutrons, was measured repeatedly. It was found to be $a = -(3.5 \pm 1.2) \cdot 10^{-4}$. The mean value of a in both our experiments is $a = -(3.6 \pm 0.7) \cdot 10^{-4}$. In the repeated experiment the effect of the apparatus instability was eliminated by the fast neutron spin flip and by comparing the effects for two opposite directions of spins. Preliminary threshold tunnel diode discriminators which control the linear gate schemes were introduced to unload one-channel differential analyzers detecting the γ quanta energy. The results obtained confirm the previously made conclusion on the existence of the weak nucleon–nucleon potential violating space parity. (auth)

Applications (Strong)

Refer also to abstract 3516.

3721 (DESY-69/35) RADIATIVE X^0 DECAYS IN BROKEN SU(3). Singer, Paul (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1969. 8p. Dep. CFSTI (U. S. Sales Only).

The radiative decays of the X^0-meson are analyzed in the framework of an effective Lagrangian with vector-meson dominance, using vector gauge fields with current mixing and assuming X^0 to be a unitary singlet. The underlying VVP strong interaction obeys octet-broken SU(3) symmetry. The model is shown to predict branching ratios different from those obtained in the η-X^0 mixing model. An analysis of the experimental situation is presented and the relevance of the $X^0 \to 2\gamma$, $X^0 \to \omega\gamma$ partial decay modes for distinguishing between different theoretical models is pointed out. (auth)

3722 SU(3) MODEL OF DOUBLE OCTETS. Graham, R. H.; Moffat, J. W. (Univ. of Toronto). Phys. Rev., 184: 1905-7 (Aug. 25, 1969).

On the assumption that both peaks of the A_2 have $J^P = 2^+$, an SU(3) double octet model is proposed. A sum rule predicts a $K_{N'}$ at ≈1300 MeV and implies that the two octets can be manifestations of an octet of fundamental double poles. Predictions of partial widths for the decays of the two octets are in reasonable agreement with experiment. The sum rule is also well satisfied for two octets of $J^P = 1^+$ mesons and for two octets of $J^P = 1^-$ mesons, provided the ρ' and $K^{*\prime}$ mesons are degenerate in mass with the ρ(765) and K^*(890). (auth)

3723 A_2 SPLITTING AND A NEW DUALITY FOR BROKEN INTERNAL SYMMETRIES. Tuan, S. F. (Univ. of Hawaii, Honolulu). Phys. Rev. Lett., 23: 1198-1201(Nov. 17, 1969).

It is proposed that both SU(3) and broken nonchiral SU(2) ⊗ SU(2) internal symmetries are relevant for classification of hadronic states. The theory explains the A_2 splitting while predicting the existence of at least one abnormal meson with $(I^G, J^P) = (2^-, 2^+)$ degenerate in mass with the A_2. (auth)

3724 SCALAR DENSITIES AND MESONS. Lee, Y. Y. (Univ. of Chicago). Nuovo Cim., 64A: 474-84(Nov. 21, 1969).

It is assumed that the strong-interaction Hamiltonian is broken from the chiral $SU_3 \times SU_3$ symmetry by scalar densities $(u_0 + cu_8)$, where c is a parameter and u_0, u_8 transforms like components of the $(3,\bar{3}) + (\bar{3},3)$ representation of the chiral $SU_3 \times SU_3$ group. An assumption of asymptotic symmetry on this scalar and pseudoscalar densities is also made. Calculations are made to correlate the pseudoscalar mesons as well as the much proposed kappa-meson. The η-X mixing problem is also tried. (auth)

3725 MESON–BARYON COUPLINGS AND K^-p REACTIONS. Das Gupta, S.; Mohana, B. K. (Univ. of Delhi). Nuovo Cim., 64A: 325-36(Nov. 21, 1969).

A phenomenological model of meson-baryon, couplings based on a quark model with broken $SU_6 \otimes O_3$, proposed recently, is used for the calculation of certain K^-p reactions via the s-channel, with the inclusion of baryon resonances belonging to $(\underline{70}, 1^-)$ and $(\underline{65}, 2^+)$ supermultiplets. The results which show fairly good agreement with the experimental data on K^-p total cross-sections as well as the $\Sigma\pi$ and $\eta\Lambda$ reactions, bring out the sensitive dependence of the assumed form factors on the masses and momenta involved. (auth)

3726 CHIRAL $SU_3 \times SU_3$ ALGEBRA AND APPROXIMATE $SU_2 \times SU_2$ SYMMETRY. Fuchs, N. H.; Kuo, T. K. (Purdue Univ., Lafayette, Ind.). Nuovo Cim., 64A: 382-96(Nov. 21, 1969).

The implications of the validity of chiral $SU_3 \times SU_3$ current algebra and the assumption that the chiral-symmetry breaking term transforms according to the $(3,3^*) + (3^*,3)$ representation of $SU_3 \times SU_3$ are investigated. It is argued that approximate $SU_2 \times SU_2$ symmetry is expected on the grounds of the smallness of the pion mass together with some reasonably smooth behavior for matrix elements which involve a pion. The PCAC hypothesis, in its pole-dominance form, is applied to the π,K and η cases in a step-by-step manner. Some results are obtained for the K_{l3} form factors, including $f_+(0) = 1$. Except for the equal-time commutation relations, SU_3 symmetry is not invoked even approximately. Sum rules involving f_π, f_K, f_η and the pseudoscalar-meson masses are derived, some of which differ significantly from those obtained previously using approximate SU_3 symmetry. In particular, an expression for f_K/f_π is inferred which involves pseudoscalar-meson masses alone. (auth)

3727 AN ITERATIVE METHOD TO SATURATE THE CHIRAL $SU_3 \otimes SU_3$ ALGEBRA IN A NONFINITE SET OF ONE-PARTICLE STATES. Buccella, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Celeghini, E.; Sorace, E. Nuovo Cim., Lett., 2: 571-7(Oct. 21, 1969).

The general solution for the first step of a previous iteration procedure, which overcomes the difficulties of the approximate saturation hypothesis for the classification of baryon states in (56,2n) and (70,2n+1) representations of SU(6) ⊗ O(3), is given. It is shown that this solution obeys all the required conditions, that is for the cases solved there is no other solution, and it is believed that this is true in general. (J.F.P.)

Field Theories

General

3728 SPACE–TIME CODE. Finkelstein, David (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 184: 1261-71(Aug. 25, 1969).

It is known that the entire geometry of many relativistic space-times can be summed up in two concepts, a space-time measure μ and a space-time causal or chronological order relation C, defining a causal measure space. On grounds of finiteness, unity, and symmetry, it is argued that macroscopic space-time may be the classical-geometrical limit of a causal quantum space. A tentative conceptual framework is provided. Mathematical individuals that naturally form causal spaces are symbol sets or words, taken in the order of their generation. The natural extension of this purely logical concept to quantum symbols is formulated. The problem is posed of giving finite quantum rules for the generation of quantum symbol sets such that the order of generation becomes, in the classical limit, the causal order of space-time—as it were, to break the space-time code. The causal quantum spaces of three simple codes are generated for comparison with reality. The singulary code (repetitions of one digit) gives a linearly ordered external world of one time dimension and a circular internal space. The binary code gives the future null cone of special relativity and a circular internal space. The causal quantum space of word pairs in the binary code gives the solid light cone $t > (x^2 + y^2 + z^2)^{1/2}$ of special relativity and an internal space U(2,C) suitable for the description of charge and isospin. In the classical limit, there is full translational and proper Lorentz invariance except at the boundary of the light cone, where the classical-geometrical limit fails. Plausible consequences of this model for cosmology and elementary particles are discussed. There is a quantum of time $\tau \lesssim \hbar/m_\mu c^3$ and a space-time complementarity relation $\Delta t \Delta x \Delta y \Delta z \gtrsim \tau^4$. (auth)

3729 HAMILTONIAN FORM OF ELECTROMAGNETIC EQUATIONS. Brinis, Elisa Udeschini. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 46: 33-9(Jan. 1969). (In Italian).

By assuming as canonical variables the components of two potential vectors and their conjugate momentum densities, the Hamiltonian function for space-time electromagnetic field is constructed and all electromagnetic field equations are presented in Hamiltonian form. (auth)

3730 PAIR PRODUCTION BY A CONSTANT EXTERNAL FIELD. Nikishov, A. I. (Lebedev Inst. of Physics, Moscow). Zk. Eksp. Teor. Fiz., 57: 1210-16(Oct. 1969). (In Russian).

Solutions of the Dirac equation in a stationary electromagnetic field are obtained and their properties are analyzed. A causal Green function is set up in Feynmann representation. The differential probability for pair production by an external field is found and the pair annihilation probability in a field without photon emission is determined. (auth)

Quantum Field Theory

Refer also to abstracts 3547, 3556, and 3585.

3731 (ITF–69-36) SUBTRACTIVE FORMALISM IN THE QUANTUM ELECTRODYNAMICS. Shcherbina, V. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 86p. (In Russian). (CONF-690417-19). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

There is constructed the sequence $H_N(t)$ of nonlocal bounded self-adjoint interaction Hamiltonians formally amounting to the renormalized Hamiltonian of the quantum electro-dynamics. A special boundary transition rigorously resolves itself into the principal results of previous local theory. (auth)

3732 (PURC–2137-14) QED EXPERIMENTS WITH MUONS. Chen, K. W. (Princeton Univ., N. J.). [1969]. Contract AT(30-1)-2137. 15p. Dep. CFSTI.

The μ experiments primarily studying quantum electrodynamics (QED) at small distances or μ-e differences are considered. Several of these experiments appear attractive at NAL without regard to the storage-ring considerations. The quality of muon beam required and sensitivity of the experiment to QED breakdown are presented. (auth)

3733 FEYNMAN-LIKE DIAGRAMS COMPATIBLE WITH DUALITY. I. PLANAR DIAGRAMS. Kikkawa, K.; Sakita, B.; Virasoro, M. A. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 184: 1701-13(Aug. 25, 1969).

A perturbative approach in which the Veneziano representation plays the role of a Born term is proposed. Veneziano's formula is interpreted as describing only the contribution of one-particle intermediate states. The contribution of many-particle intermediate states is added by means of Feynman-like diagrams. The rules for writing the integrals corresponding to any planar diagram are given. Crossing symmetry, duality, and Reggeization

are explicitly taken into account. The asymptotic behavior of each Feynman-like diagram is found. It is proved that the whole amplitude has Regge behavior. The new trajectory, however, is no longer linear, and it incorporates correctly the elastic unitarity constraint. It is argued that this approach will ultimately provide a framework in which generalized unitarity (in Cutkosky's sense) can be imposed. (auth)

3734 ANOMALOUS WARD IDENTITIES IN SPINOR FIELD THEORIES. Bardeen, William A. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 184: 1848-59(Aug. 25, 1969).

The model of a spinor field is considered with arbitrary internal degrees of freedom having arbitrary nonderivative coupling to external scalar, pseudoscalar, vector, and axial-vector fields. By carefully defining the S matrix in the interaction picture, the vector and axial-vector currents associated with the external vector and axial-vector fields are found to satisfy anomalous Ward identities. If it is required that the vector currents satisfy the usual Ward identities, the divergence of the axial-vector current contains well-defined anomalous terms. These terms are explicitly calculated. (auth)

3735 ANOMALOUS COMMUTATORS AND THE TRIANGLE DIAGRAM. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.); Boulware, David G. Phys. Rev., 184: 1740-4(Aug. 25, 1969).

Matrix elements of the axial-vector current in spinor electrodynamics are considered, and the change in the usual reduction formalism caused by the presence of the axial-vector-current–two-photon triangle diagram is developed. When at most one photon is reduced in from the external states, the anomalous behavior of the triangle diagram can be characterized entirely in terms of a consistent set of anomalous field-current and current-current commutators. (auth)

3736 MASSIVE GAUGE THEORY AND WEAK FORM FACTORS. Chen, T. W. (New Mexico State Univ., Las Cruces). Phys. Rev., 184: 1673-6(Aug. 25, 1969).

Closely following the theory of Yang and Mills, massive gauge theories are formulated for a four-vector field which is a mixture of spin-1 and spin-0 particles. The gauge invariance of theories can be maintained within the present framework even for massive spin-1 particles. Furthermore, interactions can also be generated for spin-0 particles. The usual gauge transformation for massive electrodynamics is discussed, as well as the chiral gauge transformations. The interactions so generated are shown to lead to the modified Goldberger–Treiman relation. (auth)

3737 WEINBERG'S PERTURBATION THEORY AT INFINITE MOMENTUM. Manning, Irwin (Naval Research Lab., Washington, D. C.). Phys. Rev., 184: 1957(Aug. 25, 1969).

Weinberg has shown that old-fashioned perturbation theory simplifies if carried out in the $P \to \infty$ frame. It is shown by a counterexample that his analysis, restricted to spin-0 particles, cannot be extended to the general case without modifications which will erode some of the simplicity of the original results. His "new rules" are extended to include spin-½ particles. (auth)

3738 EQUAL-TIME COMMUTATORS AND FORM FACTORS IN QUANTUM ELECTRODYNAMICS WITH INTERNAL SYMMETRY. Katz, J.; Langerholc, J. (Univ., Hamburg. Deutsches Elektronen-Synchrotron, Hamburg). Phys. Rev., 184: 1577-93 (Aug. 25, 1969).

Isospin currents are constructed in second-order perturbation theory by iterating the Yang–Feldman equations and renormalizing. The conventional method of subtracting divergences is replaced by a deductive approach in which Lorentz covariance and locality of the currents determine, up to a polynomial, the form factors which remain after renormalization. It is observed that any such polynomials occurring in addition to the usual expression for the form factors will cause not only an undesirable increase in the currents themselves at high energies, but also to a series of extra terms in the commutators of the electric currents. The commutators of the currents so defined are calculated by smearing the commutator in the time difference with a test function of class S which is allowed to approach a δ function in the appropriate topology (δ sequence). Attention is restricted here to those parts of the commutator connected with the vacuum-polarization correction to the electric form factors. It is found that the equal-time commutator does not exist in those cases where the result expected on the basis of a calculation with canonical commutation relations does not vanish. In this case, the renormalized current reappears along with several divergent integrals which are damped by the test functions of the δ sequence in p space. This causes the limit to be strongly dependent on the choice of the sequence, enabling either finite or infinite results to be obtained. The reason for this is that the commutator as a function of the time difference is not a continuous function at the origin, and thus the "equal-time value" has no meaning. The nature of the singularities occurring is studied, and they are displayed explicitly in x space. The question of the existence of time-ordered and retarded commutators is investigated. (auth)

3739 ANHARMONIC OSCILLATOR. Bender, Carl M.; Wu, Tai Tsun (Harvard Univ., Cambridge, Mass.). Phys. Rev., 184: 1231-60(Aug. 25, 1969).

The anharmonic oscillator defined by the differential equation $(-d^2/dx^2 + \frac{1}{4}x^2 + \frac{1}{4}\lambda x^4)\Phi(x) = E(\lambda)\Phi(x)$ and the boundary condition $\lim_{x\to\pm\infty} \Phi(x) = 0$ is considered. This model is interesting because the perturbation series for the ground-state energy diverges. To investigate the reason for this divergence, the energy levels of the Hamiltonian H are analytically continued into the complex λ plane. Using WKB techniques, it is found that the energy levels as a function of λ, or more generally of λ^α, have an infinite number of branch points with a limit point at $\lambda = 0$. Thus, the origin is not an isolated singularity. Level crossing occurs at each branch point. If $\alpha = \frac{1}{3}$ is chosen, the resolvent $(z - H)^{-1}$ has no branch cut. However, for all z it has an infinite sequence of poles which have a limit point at the origin. The anharmonic oscillator is of particular interest to field theoreticians because it is a model of $\lambda\varphi^4$ field theory in one-dimensional space-time. The unusual and unexpected properties exhibited by this model may give some indication of the analytic structure of a more realistic field theory. (auth)

3740 FIELDS AND/OR PARTICLES. Sen, D. K. Toronto, Ryerson Press, 1968. 139p.

A survey is presented of the essentials of some fundamental theories of physics in the areas of electrodynamics, gravitation and quantum theory, with the aim of discussing the concept of field-particle duality. Theories are classified into three distinct categories: dualistic, nondualistic, and unified nondualistic. Illustrative examples are taken from the not so well established theories as well as from the well established. For example, the electrodynamics of Mie and of Born and Infeld are discussed. The development of the underlying theme did not require the inclusion of axiomatic quantum field theory or S-matrix and dispersion theory; symmetries are mentioned only as needed to explain Heisenberg's unified field theory. (G.L.W.)

3741 FURTHER EXACT RESULTS IN TWO-DIMENSIONAL SPINOR ELECTRODYNAMICS WITH NONVANISHING FERMION MASS. Haberler, P. L. F. (CERN, Geneva). Nuovo Cim., 64A: 405-33(Nov. 21, 1969).

The exact axial vector current in two-dimensional electrodynamics with nonvanishing fermion mass is constructed using methods of Wilson and Brandt. It is shown that $j_\mu^{5\,\mathrm{un}}(x) = \partial_\mu\phi(x)$, where $j_\mu^{5\,\mathrm{un}}(x)$ is the exact unrenormalized axial vector current and $\phi(x)$ is a pseudoscalar canonical field. The problem of constructing the correct Lagrangian for this model is also solved. (auth)

3742 MASSIVE YANG–MILLS FIELDS. Reiff, J. (Inst. for Theoretical Physics, Utrecht); Veltman, M. Nucl. Phys., B13: 545-64(1969).

Two problems are studied in the paper: (i) the relation between Lagrangian and Feynman rules if the Lagrangian contains derivative couplings and/or vector meson fields and (ii) the behavior of certain two closed loop diagrams in the perturbation theory of Yang-Mills fields. With respect to (i), using an extremely simple regularization procedure, the canonical formalism is shown to give directly manifestly covariant Feynman rules. With respect to (ii), a certain set of Feynman rules involving ghost particles is known to be valid for diagrams of the Yang-Mills theory with no or one closed loop. It is shown however that with the same set of rules the imaginary part of the two-loop self-energy diagrams receives a non-zero contribution of the unphysical three-ghost intermediate state. (auth)

3743 SOME CONSIDERATIONS ON THE EFIMOV–FRADKIN METHOD IN NON-LINEAR FIELD THEORIES. Lee, Benjamin W.; Zumino, Bruno (CERN, Geneva). Nucl. Phys., B13: 671-86 (1969).

The method, due to Efimov and Fradkin, of formal summation of the perturbation series in non-linear field theories is studied in the context of a simple model which bears some similarity to the chiral dynamics Lagrangians. The question of the precise mathematical meaning of the "formal sum" of Efimov and Fradkin (in particular, the question of uniqueness of the sum and that of "contours in auxiliary variable" posed by Delbourgo, Salam and Strathdee), and the analytic properties of the resulting amplitude are considered. It is shown that the summation method of Efimov and Fradkin, with its precise mathematical meaning given in the text, produces a finite function having the correct analyticity properties

and imaginary part implied by unitarity requirements. Ambiguities present in summing the perturbation series are not completely eliminated by the considerations of unitarity and analyticity. It is noted in passing that the resulting two-point function is non-local. (auth)

3744 THEORY OF INTERACTIONS OF TWO ELECTRONS. Shirokikh, V. D. (Moscow State Univ.). Yadern. Fiz.; 10: 668-9(Sep 1969). (In Russian).

In the framework of relativistic quantum electrodynamics, the existence of a new form of the Breit interaction operator is established. (auth)

3745 GENERALISATION OF THE LORENTZ TRANSFORMATION. Alway, G. Nature (London), 224: 155-6(Oct. 11, 1969).

In connection with the principle of special relativity it is stated that because the Lorentz transformation embodies the principle of the equivalence of all initial frames it has been assumed that all physical theories should be invariant under this transformation. There is, however, a more general transformation including the Lorentz as a special case, and this could be of significance for physical theory. The Lorentz transformation was derived from the assumptions of (1) inertial frame equivalence, (2) linearity, and (3) isotropic behavior of clocks. Assumption (3), however, seems unlikely; modern theories of gravitation do not assume that space is isotropic, and even when a gravitational field is absent the presence of other fields make (3) a hazardous assumption. Assumption (3) is essential if the Lorentz transformation is to be derived. Other transformations satisfying only (1) and (2) are discussed, and the behavior of clocks and rigid bodies as given by these transformations is discussed, and it is shown how these transformations are a generalization of the Lorentz case. (UK)

3746 CONSTRUCTION OF CANONICAL OPERATORS IN NONCANONICAL FIELD THEORIES. Duerr, H. P.; Mitter, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 64A: 715-26(Dec. 1, 1969).

If regularization (and as a consequence indefinite metric in the state space) is taken seriously such that, e.g., the propagator falls off more rapidly than for a free field, the conventional bilinears cannot be used for the construction of generators of symmetry transformations, since they commute with the fields at equal times. Starting from some assumptions on the structure of the commutation relations of the fields at equal times it is shown, that it is possible to construct a local current with the correct canonical communication relations for a certain class of regularized field theories. The current is still bilinear but involves higher derivatives of the fields. It is also possible to construct new fields, which fulfil the canonical commutation relations at equal times. Under special circumstances the spectral function of the new propagator can be required to be positive definite. (auth)

3747 INSTABILITY OF SOLUTIONS AND COMPOSITE PARTICLES IN QUANTUM FIELD THEORY. Tirapegui, E. (College de France, Paris). Nuovo Cim., 64A: 727-32(Dec. 1, 1969).

It is shown that critical values of the coupling constant which make the renormalization constant of a field vanish correspond to instability points of the solutions of the theory. (auth)

3748 CLASSICAL AND QUANTUM FIELDS IN DE SITTER SPACE. Boerner, G.; Duerr, H. P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 64A: 669-714 (Dec. 1, 1969).

In the (1 + 4) de Sitter space the equations for free fields of spin 0, spin ½ and spin 1 are derived as eigenvalue equations of the Casimir operators. Completeness relations for the solutions are given in the case of spin 0 and spin ½, and with these the different Green functions and commutation functions are obtained. It is possible to construct causal commutation functions only for a certain part of the spectrum. This gives rise to a spectrum condition, by which, e.g., the solution satisfying the conformal invariant equation for spin 0 is excluded from the physical state space. All functions are shown to permit an expansion in powers of the de Sitter curvature 1/R, where the first term is in each case the corresponding invariant function of Minkowski space. (auth)

3749 ON THE RELATIVISTIC LIMIT OF SPIN-TENSOR OPERATORS AND WIGNER'S LITTLE-GROUP GENERATORS. Beckers, J. (Univ., Liege). Nuovo Cim., 64A: 494-500 (Dec. 1, 1969).

Recently, spin-tensor operators for arbitrary spin have been obtained by De Vos and Hilgevoord, generalizing the well-known conserved spin tensor of Hilgevoord and Wouthuysen in the spin one-half case. The relativistic limit of these operators is considered and studied in connection with Wigner's little-group generators. Particular emphasis on the spin one-half case is given. (auth)

3750 COUPLED SELF-INTERACTING REAL SCALAR FIELD THEORIES. Brett, A. M. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim., 64A: 507-27(Dec. 1, 1969).

The Rayleigh-Ritz procedure for functionalities is used to deduce criteria for a nonlinear, relativistic, theory of two coupled self-interacting quantum fields to admit physically realistic vacuum, one-quantum, and two-quantum stationary states. These criteria suggest that for two-quantum bound and scattering states to be admitted, mass renormalization, together with renormalization of the generic interaction coefficients is required. The form of the renormalization is derived and discussed. (auth)

3751 CONVERGENT FIELD THEORY WITH COMPLEX MASSES. Yamamoto, Hiroshi (Fukui Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 707-14(Sept. 1969).

A consistent and convergent field theory is constructed. For this purpose the propagation functions are improved. The new propagators have to satisfy several conditions. Among these conditions the most interesting ones are "definite norm," "divergenceless" and "causality." It turns out that the new propagators include necessarily complex masses which have very close connection with "causality." In order to examine this problem the propagator is studied carefully in a simple case, and is found to be macrocausal. It is suggested that the theory is connected with the validity of quantum electrodynamics at small distances and could be tested by experiments. (auth)

3752 STUECKELBERG FORMULATION OF THE ISOVECTOR, AXIAL-VECTOR FIELD. Abe, Mitue (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 42: 738-40(Sept. 1969).

The Stueckelberg formulation for an isovector axial-vector field is introduced, and the massless pion field is considered. The extension of the usual formalism to the axial-vector field is straighforward. Instead of vector coupling the coupling in this case is pv(pv)-one. (J.F.P.)

3753 NILPOTENT LOCALLY CONVEX LIE ALGEBRAS AND LIE FIELD STRUCTURES. Limic, N. (Inst. for Advanced Study, Princeton, N. J.). Commun. Math. Phys., 14: 89-107(1969).

Lie field structures are joined with certain infinite-dimensional Lie algebras with locally convex topology. These topological Lie algebras allow topological groups which are a generalization of the connected nilpotent Lie groups. The existence of the continuous unitary representations of the gained groups is shown, and then the analog of Garding theorem is proven. Using this theorem the existence of representations of Lie field structures into Lie algebras of skew-symmetric operators on Hilbert spaces is established. (auth)

3754 SILOV BOUNDARY OF THE VERTEX FUNCTION. Glueck, M. (Technion-Israel Inst. of Tech., Haifa). Commun. Math. Phys., 14: 108-119(1969).

The Šilov boundary of the vertex function is computed without resource to analytic completion techniques. (auth)

3755 PHYSICAL SYMMETRIES IN A THEORY OF SEVERAL SCALAR REAL FIELDS. Lopuszanski, Jan T. (Univ. of Wroclaw). Commun. Math. Phys., 14: 158-64(1969).

A theory of n scalar, real, local, Poincaré covariant quantum fields forming an irreducible set and giving rise to one particle states belonging to the same mass different from zero is considered. The vacuum is unique. It is shown under fairly weak assumptions that every Poincaré and TCP invariant symmetry of the theory, implemented unitarily, which maps localized elements of the field algebra into operators almost local with respect to the former (such a symmetry we call a physical one) can be defined uniquely in terms of the incoming or outgoing fields and an n-dimensional (real) orthogonal matrix. The symmetry commutes with the scattering matrix. Incidentally it is shown also that the symmetry groups are compact. A special case of these symmetries are the internal symmetries and symmetries induced by locally conserved currents local with respect to the basic fields and transforming under the same representation of the Poincaré group. Linear combinations may then be made out the original fields resulting in complex fields and its complex conjugate in a suitable way. The inspection of the representations of the groups SO(n) and their subgroups sheds some light on the s.c. generalized Carruthers Theorem concerning the self- and pair-conjugate multiplets. (auth)

Gravitation and General Relativity

Refer also to abstract 3551.

3756 EXPERIMENTAL TEST OF THE EQUIVALENCE PRINCIPLE FOR PHOTONS. Shamir, J.; Fox, R. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., 184: 1303-4(Aug. 25, 1969).

Some time ago, Yilmaz suggested an experiment to test the equivalence principle for photons. Such an experiment is reported here. Theoretically, a violation of the equivalence principle could lead to an anisotropy in the velocity of light with respect to the sun of the order $\Delta c/c \sim 9 \times 10^{-9}$. Experimentally, an upper limit of 3×10^{-11} was found for $\Delta c/c$. (auth)

3757 GRAVITONS AS GOLDSTONE BOSONS. Ohanian, Hans C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 184: 1305-12(Aug. 25, 1969).

A Lagrangian model is constructed in which gravitons appear as Goldstone bosons associated with a breaking of Lorentz symmetry. It is assumed that a fermion field interacts with itself by a tensor-tensor coupling. The invariance of the vacuum state under Lorentz transformations is violated by assigning a nonzero vacuum expectation value to the tensor. Interactions between the fermions and this nonzero vacuum tensor are treated by a Hartree-Fock procedure; other interactions are treated by perturbation theory. The divergent integrals that appear are handled by a cutoff whose magnitude, expressed as a length, is of the order of 10^{-33} cm. When the S matrix for fermion-fermion scattering is calculated in first approximation, "gravitons" make their appearance as poles at momentum transfer $k^2 = 0$. These gravitons also appear as solutions of the Bethe-Salpeter equation for bound fermion-antifermion states. The model reproduces the results of the linear approximation to gravitational theory. (auth)

3758 EXACT METRIC FOR A NONROTATING MASS WITH A QUADRUPOLE MOMENT. Young, John H.; Coulter, C. Alton (Clark Univ., Worcester, Mass.). Phys. Rev., 184: 1313-15 (Aug. 25, 1969).

Erez and Rosen have given a method for calculating an exact static metric for a nonrotating, cylindrically symmetric mass distribution possessing multipole moments of arbitrary order; however, the explicit expressions they give for the metric components arising from a combination of monopole and quadrupole moments contain errors. In this paper, the Erez-Rosen method is outlined and then the corrected form of the metric is stated for this experimentally significant case of a mass distribution with monopole and quadrupole moments. (auth)

3759 SOLUTIONS OF THE EINSTEIN AND EINSTEIN-MAXWELL EQUATIONS. Debney, G. C. (Virginia Polytechnic Inst., Blacksburg); Kerr, R. P.; Schild, A. Contract F 33615-68-C-1675. J. Math. Phys. (N. Y.), 10: 1842-54(Oct. 1969).

Algebraically degenerate solutions of the Einstein and Einstein-Maxwell equations are studied. Explicit solutions are obtained which contain two arbitrary functions of a complex variable, one function being associated with the gravitational field and the other mainly with the electromagnetic field. (auth)

3760 LOWER LIMIT SET TO PLANCK'S CONSTANT BY WAVE MECHANICS INCLUDING GRAVITATION. Efinger, H. J. (Univ. of Georgia, Athens). Physica, 44: 318-20(Sept. 15, 1969).

A lower bound for the numerical value of Planck's constant is estimated on theoretical grounds alone, if elementary particles are gravitating entities. (auth)

3761 ESSENTIAL SINGULARITIES IN GENERAL RELATIVITY. Deser, S. (Brandeis Univ., Waltham, Mass. NORDITA, Copenhagen); Higbie, J. Phys. Rev. Lett., 23: 1184-6(Nov. 17, 1969).

Spherically symmetric initial solutions of the coupled gravitational-massless scalar field-"charged particle" system are exhibited. For a given set of coupling constants, there are generally either no or two nonsingular solutions. In the latter case, one of these has essential singularities in the scalar and gravitational constants at zero coupling. Other properties of the solutions are listed. The corresponding results in tensor-scalar gravitation are also outlined. (auth)

3762 CHARGED SPHERES IN GENERAL RELATIVITY. Faulkes, M. C. (Queen's Univ., Kingston, Ont.). Can. J. Phys., 47: 1989-94(Sept. 15, 1969).

The Einstein-Maxwell equations for a spherically symmetric distribution of charged matter are studied. A general equation is derived for the rate of the "total energy" of the sphere in terms of the 4-4 component of the electromagnetic and matter tensors. It is shown that, subject to certain conditions, the spheres of charged matter can oscillate, and further that the static configuration is uniquely given by the relation $m^2 = 4re^2\alpha$, where $\alpha(\leq 1) = m/r_0$. Finally, it is demonstrated that the equilibrium configuration is unstable to small radial perturbations. (auth)

3763 NEUTRINO AND THE THEORY OF GRAVITATION. Kuchowicz, B. (Univ. of Warsaw). Fortschr. Phys., 17: 517-34(1969).

A review is given of those topics in the theory of neutrino in gravitational fields which do not explicitly enter cosmology. These include classical motion of the neutrino; gravitational lenses and neutrino focusing; neutrino rest mass and superstars; neutrino chirality and gravitation; quantum neutrino dynamics in gravitational fields; and gravitation and the neutrino sea. Some possible future developments in the studies on the gravitating neutrino are listed. (L.B.S.)

3764 NOTES ON THE THEORY OF RELATIVITY. Kar, K. C. (Inst. of Theoretical Physics, Calcutta). Indian J. Theor. Phys., 17: 1-11(Mar. 1969).

Some confusions still existing in the theory of relativity are pointed out. It is shown that if the general definition of covariant vector previously given is adopted then the vector characters of any quantity encountered in physical problems can be easily determined. As a result the mass and electrostatic potential which were known to be scaler are found to be really vectors in the direction of time. Consequently it is easy to group together four vectors and linearize the quadratic Hamiltonian of Einstein. Thus it is unnecessary to use Dirac's linear Hamiltonian. It is also shown that there may be bending of light in a strong gravitational field. But in the absence of this field there can be no bending. Lastly it is pointed out that the Einstein world is restricted and one can imagine worlds in which Einstein theory is not at all applicable. (auth)

3765 BRANS SOLUTION IN THE SCALAR-TENSOR THEORY OF GRAVITATION. Narlai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 42: 742-4(Sept. 1969).

Since in order to test the Brans-Dicke scalar-tensor and Einstein tensor theories it is very desirable to find some phenomenon for which these theories give entirely different predictions, the Brans' vacuum solution (which corresponds to Schwarzschild's exterior solution in general relativity) is considered with application to gravitational collapse. It was previously pointed out that the existence of the scalar field may be ruled out if a neutron star is observed to exhibit symmetric radial pulsations. (J.F.P.)

3766 FIELD EQUATIONS IN THE NEIGHBOURHOOD OF A PARTICLE IN A CONFORMAL THEORY OF GRAVITATION. II. Islam, J. N. (Inst. for Advanced Study, Princeton, N. J. Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 313: 71-82(Oct. 14, 1969).

The field equations in the neighborhood of a particle for a spherically symmetric metric in the conformal theory of gravitation put forward by Hoyle and Narlikar are examined. As the theory is conformally invariant, different but physically equivalent conformal frames may be used to study the equations. Previously these equations were studied in a conformal frame which, though suitable far away from the isolated particle, is not suitable in the neighborhood of the particle. A solution in a conformal frame is obtained that is suitable for considering regions near the particle. The solution thus obtained differs from the previous solution in several respects. For example, it has no coordinate singularity for any nonzero value of the radial variable, unlike the previous solution or the Schwarzschild solution. It is also shown with the use of this solution that in this theory distant matter has an effect on local geometry. (auth)

3767 GRAVITATIONAL WAVES IN GENERAL RELATIVITY. XI. CYLINDRICAL-SPHERICAL WAVES. Marder, L. (Univ. of Southampton, Eng.). Proc. Roy. Soc. (London), Ser. A, 313: 83-96(Oct. 14, 1969).

Further properties of a vacuum metric obtained earlier, representing a spherical-fronted gravitational wave (which, however, possesses cylindrical symmetry) are derived. This metric is constructed by introducing "bending terms" into Rosen's metric for cylindrical waves. The way the transition occurs from properties characteristic of cylindrical waves to those of spherical waves is examined. The asymptotic behavior of the optical parameters and the null tetrad components of the Weyl (Riemann) tensor along an outgoing null geodesic is determined. An interpretation of the axial singularity is given by comparison with an analogous feature in classical electromagnetic wave propagation. (auth)

3768 CAUSAL GROUPS OF SPACE-TIME. Gheorghe, Cezar; Mihul, Eleonora (Inst. for Atomic Physics, Bucharest). Commun. Math. Phys., 14: 165-70(1969).

A finite-dimensional space, considered as a real ordered linear space, directed with respect to a partial ordering relation (causal relation) in which a given reflection (called temporal inversion) is antisotone and the positive cone is closed in the euclidean topology A generalized Zeeman theorem is obtained, which states that the causal group relative to the causal relation is a subgroup of the affine group of M. (auth)

Scattering Theory

Refer also to abstracts 3640, 3687, and 3688.

3769 (AD-691277) VENEZIANO AMPLITUDE AND LORENTZ POLES. Paciello, M. L.; Sertorio, L.; Taglienti, B. (Rome Univ. (Italy). Istituto di Fisica). Dec. 27, 1968. Contract F61052-67-C-0084. 15p. (NI-200). CFSTI.

It is shown that the s to the alpha power behavior of the Veneziano amplitude does not correspond to the existence of a simple Lorentz pole. It is shown in detail how to restore a single Lorentz pole dominance for which it is necessary to add infinite Veneziano satellites. This fact is valid both for the original Veneziano amplitude and for the Mandelstam modified amplitude. (Disser. Abstr.)

3770 (JINR-P2-4631) SCATTERING OF PARTICLES WITH NON-ORTHOGONAL INTERNAL STATES. Lyuboshits, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The elastic scattering of two particles, the internal states of which are superpositions of the $\alpha|A\rangle+\beta|B\rangle$ and $\gamma|A\rangle+\delta|B\rangle$ type, is considered. It is shown that the differential and total cross sections depend on the degree of the superposition nonorthogonality. In this case the identical superpositions of one and the same states are scattered as identical particles. The collisions of nonstationary superpositions of particles with different masses are analyzed. The dependence of the elastic and total cross section on the proper time of flight of two packets is investigated. (auth)

3771 FORMAL SOLUTIONS OF INVERSE SCATTERING PROBLEMS. Prosser, Reese T. (Dartmouth Coll., Hanover, N. H.). J. Math. Phys. (N. Y.), 10: 1819-22(Oct, 1969).

Formal solutions of inverse scattering problems for scattering from a potential, a variable index of refraction, and a soft boundary are developed using a method devised by Jost and Kohn. (auth)

3772 TWO-VARIABLE EXPANSION OF THE SCATTERING AMPLITUDE: AN APPLICATION OF APPEL'S GENERALIZED HYPERGEOMETRIC FUNCTIONS. Charap, John M.; Minton, B. M. (Queen Mary Coll., London). J. Math. Phys. (N. Y.), 10: 1823-33(Oct, 1969).

Appell's polynomials in two variables orthogonal in a triangle are described and some of their properties and those of related generalized hypergeometric functions are given. An application to the expansion of the scattering amplitude is suggested, the equal-mass case being discussed in some detail. A simple crossing matrix is derived. Difficulties introduced by inequality of the particle masses are explained. A Neumann formula is presented which permits an analytic continuation in the parameters to be made of the expansion coefficients for parts of the amplitude: This is in analogy with the Froissart-Gribov continuation. A conjectured analog of the Sommerfeld-Watson transformation then suggests the existence of fixed cuts in the partial-wave scattering amplitude. (auth)

3773 RIGOROUS LOWER BOUNDS ON THE ENERGIES OF THE N-BODY PROBLEM. Hall, R. L. (Queen's Univ., Kingston, Ont.). Phys. Lett., 30B: 320-1(Oct. 27, 1969).

A general theorem is proved which shows that the first m energies of a system of N identical particles (bosons or fermions) interacting pairwise are rigorously bounded below by the first m energies of a model system of $(N-1)$ noninteracting particles of the same symmetry type. (auth)

3774 CONFORMAL-INVARIANT SCATTERING AMPLITUDE FOR SPINLESS PARTICLES. Bali, Naren F.; Coon, Darryl D.; Katz, Amnon (Univ. of Washington, Seattle). Contract AT(45-1)-1388. J. Math. Phys. (N. Y.), 10: 1939-52(Oct. 1969).

The implications of exact conformal symmetry for the S matrix of spinless massless particles are studied. Explicit forms for the scattering amplitudes are obtained in configuration space. Differential conditions for conformal-invariant amplitudes are derived in momentum space. These are solved for the case of elastic two-body scattering and lead to an integral representation of the general two-body amplitude in terms of Lorentz scalars. The integral representation involves two arbitrary functions of two variables and four explicit quadratures. Further study of the four quadratures is made. (auth)

3775 A GUIDE TO FEYNMAN DIAGRAMS IN THE MANY-BODY PROBLEM. Mattuck, Richard D. European Physics Series. New York, McGraw-Hill Book Company, 1967. 304p. $13.50.

The topics covered include the Feynman diagrams and the many-body problem, classical and quantum quasiparticles and the pinball propagator, quasi particles in the Fermi system, ground-state energy and the vacuum amplitude, diagram methods in the many-body problem, limits of the quasiparticle theory, and the single-particle propagator. Also covered are Dyson's equation, renormalization RPA, and ladder approximations, self-consistent perturbation theory and the existence of the Fermi surface, ground-state energy of electron gas and nuclear matter, collective excitations and the two-particle propagator, Fermi systems at finite temperature, diagram methods in superconductivity, and phonons from a many-body viewpoint. (J.F.P.)

3776 MULTIPLE SCATTERING, THE GLAUBER APPROXIMATION, AND THE OFF-SHELL EIKONAL APPROXIMATION. Harrington, David R. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., 184: 1745-9(Aug. 25, 1969).

It is pointed out that in potential theory the validity of the Glauber approximation for high-energy scattering from a composite system implies a high degree of cancellation in the multiple-scattering series for the same process: The off-shell contribution to double scattering must be precisely cancelled by the sum of all higher-order terms. This cancellation holds only if the same approximations used in obtaining the Glauber formula are made in the multiple scattering series. In particular the eikonal approximation must be used for the off-shell two-body t matrices. An explicit form is developed for these approximate off-shell t matrices, and then used to verify the cancellation for some of the lower-order terms in the potentials. Possible applications of these potential-theory results to the actual relativistic scattering from composite systems are discussed. (auth)

3777 OFF-ENERGY-SHELL PARTIAL-WAVE AMPLITUDES. Mongan, Thomas R. (MITRE Corp., McLean, Va.). Phys. Rev., 184: 1888-93(Aug. 25, 1969).

Dispersion relations are presented which give the full off-energy-shell T-matrix elements $T_{ll'}(p,p';s)$ for all values of the parametric energy s in terms of bound-state form factors, a subtraction constant, and the half-off-shell T-matrix elements $T_{ll'}(p,s^{\frac{1}{2}};s)$ in the scattering $(s > 0)$ region. Study of the half-off-shell T matrix for $s > 0$ shows that it can be written as the product of a real matrix $H_{ll'}(p,s)$ and the on-shell T matrix. These results are combined to obtain a representation of the full off-energy-shell T-matrix elements in terms of experimental on-shell T-matrix elements, the real half-off-shell factors $H_{ll'}(p,s)$, a subtraction constant and bound-state form factors. The results are based only on assumptions of time-reversal invariance, off-energy-shell unitarity, analyticity, and asymptotic behavior. The results are independent of any specific dynamic assumptions. The special case of uncoupled partial waves and the advantages of a separable representation of the half-off-shell factors are discussed. (auth)

3778 3-TO-3 AMPLITUDE AND THE TRIPLE-REGGE VERTEX. Misheloff, Michael N. (Univ. of California, Berkeley). Phys. Rev., 184: 1732-6(Aug. 25, 1969).

A Reggeized model is developed for the 3-to-3 amplitude, using group-theoretical variables. The triple-Regge vertex is defined by the asymptotic form of the amplitude. It is shown that the Veneziano model has the asymptotic form predicted by our model. (auth)

3779 UNIQUENESS OF THE PARAMETRIZATION OF REGGE RESIDUES AND TRAJECTORIES FOR SMALL t. Weis, J. H. (Univ. of California, Berkeley). Phys. Rev., 184: 1527-36(Aug. 25, 1969).

The small-t expansion of Regge residues $\beta(t)$ and trajectory functions $\alpha(t)$ for arbitrary external masses and spins is discussed. The usual analyticity properties of helicity amplitudes, the factorization of Regge residues, and the requirement of consistency with coupling to unequal-mass channels are assumed. The leading t behavior (i.e., the lowest permissible power of t and its coefficient) of $\alpha(t)$ and $\beta(t)$ for the trajectories in a "family" is shown to be uniquely determined by the leading t behavior of the highest-lying trajectory(-ies) in the family. It is also shown that certain nonleading terms in the expansions of $\alpha(t)$ and $\beta(t)$ are uniquely determined by higher-lying trajectories. The relationship of various recently proposed parametrizations of $\alpha(t)$ and $\beta(t)$ to the general results is discussed. In partic-

ular, it is shown that the parametrization given by Cosenza, Sciarrino, and Toller has the most general leading t behavior permitted for residues. (auth)

3780 PARTIAL-WAVE ANALYSIS OF MANY-PARTICLE SCATTERING AMPLITUDES AND MULTI-REGGE THEORY. Hartle, James B. (Univ. of California, Santa Barbara. Massachusetts Inst. of Tech., Cambridge); Jones, C. Edward. Contract AT(30-1)-2098. Phys. Rev., 184: 1564-71(Aug. 25, 1969).

The multi-Regge prescription for the high-energy behavior of production amplitudes is derived starting from multiparticle partial-wave expansions and by employing analytic continuation in the total angular momentum of many-particle states. (auth)

3781 USE OF NONSIGNATURED PARTIAL-WAVE AMPLITUDES IN REGGE-POLE THEORY. Gaisser, T. K.; Jones, C. Edward (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 184: 1602-8(Aug. 25, 1969).

It is shown that a Froissart-Gribov-type partial-wave amplitude without signature can be defined for both two-body and multiparticle processes. Such an amplitude permits a Sommerfeld-Watson transformation, and its poles govern asymptotic behavior in the usual way, although unitarity properties of the amplitude are complicated. The relation to Toller amplitudes is discussed. (auth)

3782 COUPLED-CHANNELS MODEL OF SELF-CONSISTENT REGGE TRAJECTORIES. Caneschi, L.; Pignotti, A. (Univ. of California, Santa Barbara). Phys. Rev., 184: 1915-19(Aug. 25, 1969).

A model in which a vacuum P and a meson M Regge trajectory are present is studied in the framework of the multiperipheral bootstrap. Simultaneous self-consistency is imposed on the intercepts and slopes of both trajectories. In this model the P slope tends to be larger than the M slope, and if the P intercept at $t = 0$ is close to 1, the P exchange does not give rise to strong effects. (auth)

3783 DEVELOPMENT OF AN S-MATRIX THEORY BASED ON THE CALCULUS OF FINITE DIFFERENCES. DerSarkissian, M. (Temple Univ., Philadelphia); Nelson, T. J. Nuovo Cim., 64A: 337-44(Nov. 21, 1969).

The possibility of constructing an S-matrix theory in which partial-wave expansions are made in terms of the spin-matrix polynomials $W_n(z) = \Gamma(z + n/2 + \frac{1}{2})/\Gamma(z - n/2 + \frac{1}{2})$ is investigated. The technique employed to project an arbitrary function of z onto this basis is found in the calculus of finite differences. This circumstance seems to give the theory a flavor rather different from the conventional approach where projections are done by means of integrals. In this preliminary treatment the mathematical properties of the expansion are first presented showing how analytic continuation into the complex n-plane may be done. Then the possibility of constructing a bootstrap dynamics based on analyticity, unitarity, and crossing symmetry is discussed. (auth)

3784 NOTE ON THE NUMERICAL SOLUTION OF THE LIPPMANN-SCHWINGER EQUATION. Mongan, T. R. (MITRE Corp., McLean, Va.). Nuovo Cim., 63B: 539-48(Oct. 11, 1969).

An improved approach to the numerical solution of the Lippmann–Schwinger equation, the standard singular integral equation of nonrelativistic two-body scattering theory. This approach was extensively tested over the past three years. (auth)

3785 DESCRIPTION OF LARGE ANGLE SCATTERING. Cutkosky, R. E. (Cambridge Univ., Eng.). Nucl. Phys., B13: 351-8(1969).

A statistical model of high-energy scattering processes is developed which incorporates assumed analyticity properties. The aim is to provide a framework for the description and interpretation of large angle scattering data. A physical basis for the model is provided by the assumption that the scattering is produced by exchange of massive resonant states, which are very dense and very narrow, and extend to arbitrarily high energies in the crossed channels. The model is in qualitative agreement with present data, but more data, especially for other reactions and at higher energies, is required for the model to lead to new results or to undergo a stringent test. (auth)

3786 FACTORIZATION AND THE GENERALIZED VENEZIANO MODEL WITH SATELLITES. Gross, David J. (CERN, Geneva). Nucl. Phys., B13: 467-76(1969).

The most general form of the Veneziano N-point functions is constructed with satellites that factorize along the leading trajectory. A large class of these generalizations factorize along the non-leading trajectories. The degeneracy of the daughter levels is greatly increased. (auth)

3787 OPTICAL LIMIT OF RELATIVISTIC SCATTERING. Englert, F.; Nicoletopoulos, P.; Brout, R.; Truffin, C. (Univ. Libre, Brussels). Nuovo Cim., 64A: 561-73(Dec. 1, 1969).

The high-energy, small-angle eikonal approximation of Glauber for the elastic two-particle scattering amplitude, generalized relativistically, is obtained by summing Feynman graphs. The set of graphs considered consists of all ladder diagrams where the "rungs" criss-cross in all possible ways. The result is valid for particles carrying spin and under very general conditions for arbitrary "rungs" of the criss-cross ladder. When extended to include inelastic collisions, this method makes clear what are the necessary conditions for the absorptive-correction model to single-Regge exchange to be correct. (auth)

3788 VERTEX FUNCTIONS AT LARGE MOMENTUM TRANSFER. II. INVERSE FOURTH POWER DECREASE. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 42: 698-706(Sept. 1969).

The inverse power decrease of the form factors at large momentum transfer is argued in terms of the Jost–Lehmann–Dyson representation. The argument is made in contrast with that in previous work where the exponential decrease of the Wu-Yang type was discussed on similar grounds. (auth)

3789 ASYMPTOTIC BEHAVIOR OF SCATTERING AMPLITUDE. Hasebe, Katsuya (Aichi Univ., Toyohashi, Japan). Progr. Theor. Phys. (Kyoto), 42: 736-8(Sept. 1969).

The following result is proved without assuming a constant total cross section at infinite energy. The quantity with physical energy variable $\omega(E) \equiv [(d\sigma_+/dt)(d\sigma_-/dt)^{-1}]_{t=0}$ satisfies the following condition: If $\omega(E) = \infty$ or 0 has no solution or has at most a finite number of solutions or if $\omega(E)$ has not the limit $\lim_{E\to\infty}\omega = \infty$ or 0, then there exists an energy sequence $E_n \to \infty$ such that $\omega(E_n) = 1$ or $\omega(E)$ has the limit $\lim_{E\to\infty}\omega(E) = 1$. (J.F.P.)

3790 REGGE TRAJECTORIES WITH LEFT-HAND BRANCH LINES. Oehme, R. (ICTP, Trieste, Italy). Phys. Lett., 30B: 414-17(Nov. 10, 1969).

The conditions are explored under which Regge trajectories can have left-hand branch lines without two or more crossing pole surfaces appearing in the physical sheet of the continued partial-wave amplitude. (auth)

Particle Accelerators

Refer also to abstracts 2438, 2448, 3490, 3491, 3915, 3916, and 3953.

3791 (AD-690762) PRODUCTION OF POLARIZED ELECTRON BEAMS. Jost, K.; Zeman, H. D. (Stanford Univ., Calif. High-Energy Physics Lab.). Apr. 1969. Contract Nonr-225(67). 85p. (HEPL-590). CFSTI.

A survey of proposed and working methods for producing spin polarized electron beams is presented. An effective intensity and an effective brightness for sources of polarized electrons are derived. These quantities serve as figures of merit to compare the utility of the sources presently available. (auth) USGRDR)

3792 (BNL-14076) HYPERON BEAMS AT A 200-GeV ACCELERATOR. Berley, D. (Brookhaven National Lab., Upton, N. Y.); Lach, J. (Yale Univ., New Haven, Conn.); Maschke, A. (National Accelerator Lab., Oak Brook, Ill.); Romanowski, T. (Argonne National Lab., Ill.). June 1968. 21p. Dep. CFSTI.

The possibilities of studying hyperon interactions using the 200-GeV accelerator are discussed. This discussion covers hyperon fluxes from proton collisions, design for a hyperon beam, an experiment for the study of a hyperon (Ω^-) decay mode, and a study of $\Sigma^- + p$ elastic scattering and other two-body final states. (J.F.P.)

3793 (BNL-14083) MODULATED PROTON BEAM FOR AN RF-SEPARATED BEAM. Berley, D. (Brookhaven National Lab., Upton, N. Y.). June 1968. 8p. Dep. CFSTI.

It has been suggested that some economy may be had in the construction of an rf-separated beam by modulating the primary proton beam. The extent of the economy depends upon how the modulation is performed. If the frequency of the modulated beam is the same as the cavity frequency, a typical 100 GeV, 1.2 km, rf beam can be made shorter by 265 m. This is the distance between the target and the first deflector. It is also possible to make the frequency of the modulated beam twice the cavity frequency in which case the rf beam can be made shorter — by 610 meters, a reduction of the beam length by half. Of the several problems

associated with the modulation of the proton beam the problem of isochronism and a scheme for modulating the primary proton beam are discussed. (auth)

3794 (BNL–14106) BEAM STOP FOR 28 GeV/c PROTONS. Levine, Gerald S.; Moore, William H. (Brookhaven National Lab., Upton, N. Y.). [1967]. 11p. (CONF-691101–5). Dep. CFSTI.

From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

The design of a beam stop for terminating the external 28-GeV/c proton beam from the Brookhaven AGS is given. The beam stop is a steel parallelepiped 18 feet long, 12 feet wide, and 10 feet high with a high density core made of tungsten, uranium, and steel. A steel-filled Helmholtz coil follows the high density core to deflect negative muons upward and positive muons downward. Results of particle flux density measurements are included. (W.H.K.)

3795 (BNL–14107) THE BROOKHAVEN AGS RING RADIATION MONITORING SYSTEM. Levine, Gerald S. (Brookhaven National Lab., Upton, N. Y.). [nd]. 11p. (CONF-691101–6). Dep. CFSTI.

From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

A new radiation monitoring system is described which provides digital information on the location and temporal distribution of radiation in the AGS ring. Ionization chambers, symmetrically placed, convert absorbed radiation into pulse information which is passively transmitted to the control room where it is displayed as the data accumulates, is recorded permanently, and is available for counting and scope monitoring. A unique binary display of intensity at each location, as it appears during the accelerator cycle provides an easily comprehended picture of the radiation losses in the machine. The system is insensitive to radiation damage since all the electronics except a pulse transformer are outside the ring. The detectors are nominally calibrated for one output pulse for each millirad of absorbed dose, and are capable of counting with a pulse pair separation of less than 40 microseconds. The system specifications are outlined, its limitations defined, and operating experience and utility in accelerator tuning and operation described. (auth)

3796 (BNL–14138) A BRIGHT HIGH-GRADIENT 750-keV ION GUN. Sluyters, Th. J. M.; Amari, R.; Kovarik, V.; Lockey, R.; Senator, S. (Brookhaven National Lab., Upton, N. Y.). 15 Oct 1969. 55p. Dep. CFSTI.

A one-meter-long, air-insulated, Pierce electrostatic accelerator of 750 keV is described in detail. It has an accelerating length of only 17 cm and there is no prefocusing lens. Optically clean pulsed beams of 200 mA have been obtained, using a duoplasmatron with expanded plasma cup. The accelerator has been in continuous operation as preinjector for the Brookhaven Alternating-Gradient Synchrotron since October 1968. (auth)

3797 (CERN–69–27) FEEDBACK DAMPING OF HORIZONTAL BEAM TRANSFER ERRORS. Keil, E.; Schnell, W.; Strolin, P. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 13, 1969. 16p. Dep. CFSTI (U. S. Sales Only).

During the transfer from the PS into the ISR, the proton beam passes—among other deflecting magnets—two fast kicker magnets. Their errors induce a horizontal coherent dipole type betatron oscillation of the circulating beam in the ISR with a substantial amplitude. If nothing is done about this oscillation while it is still coherent, it will cause an increase of the radius of the injected beam by the amplitude of the coherent oscillation. However, the coherent betatron oscillation of the bunched injected beam can be detected with pickup stations and the error signal can be fed back into the beam via a suitable amplifier and correction kicker. Since the errors of the kicker magnets are a few percent of their total strengths, and since the forced betatron oscillation remains coherent for some hundred revolutions, the strength of the correction kicker turns out to be about one per mille of the strength of an injection kicker magnet. A quantitative basis for the discussion of a feedback damping system for horizontal dipole mode injection errors in the ISR is established, and expected improvements in the operation and performance of the ISR are discussed. (W.H.K.)

3798 (JINR–P9–4678) EXTRACTION OF THE ELECTRON RING FROM ADGEZATOR. Reshetnikova, K. A.; Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

To extract the electron ring (containing ions) from the adgezator it is suggested to use additional coils, which are powered at a specified time. This moment is chosen at the increasing field in the main coils. Owing to the induction field, a part of the magnetic barrier is eliminated and the distribution of the magnetic field, necessary for the ring extraction, is created by the end of the process. Gradients of the magnetic field necessary for ion holding are maintained due to the additional coils. (auth)

3799 (JINR–P9–4728) COHERENT ENERGY LOSSES OF A RELATIVISTIC BUNCH IN LINEAR ACCELERATING SYSTEMS. Kuznetsov, A. B.; Rubin, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1969. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The effect of the coherent radiation on the acceleration process of highly-charged bunches is considered. The dependence of the energy losses of a relativistic charge, passing various periodic structures, on the energy of this charge is analyzed. (auth)

3800 (JINR–P16–4727) RADIATION ESCAPE BEYOND THE SHIELDING OF THE JINR SYNCHROCYCLOTRON. Aleinikov, V. E.; Kimel, L. P.; Komochkov, M. M.; Sidorin, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1969. 8p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Using a proportional BF_3-counter with the polyethylene moderator, the measurements of the neutron fluxes of different energy groups, escaping the shielding of the 680 MeV synchrocyclotron, were performed. The total yield of neutrons beyond the accelerator shielding is determined. (auth)

3801 (LA-tr-69-23(Draft)) DESIGN OF THE ISOCHRONOUS CYCLOTRON LABORATORY OF THE I. V. KURCHATOV INSTITUTE OF ATOMIC ENERGY. Venikov, N. I.; Ogloblin, A. A.; Khaldin, N. N.; Kondrashev, L. F. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report IAE–1888. 13p. Dep. CFSTI.

The laboratory is based on the U-240 isochronous cyclotron designed at the D. V. Efremov Scientific Research Institute of Electrophysical Apparatus. To expand the possibilities of the accelerator, an axial injector of ions from external sources (polarized protons, tritium, lithium, heavy ions) and a device for obtaining intensive pulsed neutron beams are planned. To improve the energy discontinuity of the beam ±0.02% without loss of intensity, a special system of external monochromatization will be used. Obtaining heavy ions preliminarily accelerated in a tandem (an electrostatic electron-stripping) generator and injected into the U-240 with stripping of the electrons inside the latter is specified for the future. (auth)

3802 (LIB/Trans–205) ELECTROSTATIC FIELD OF EQUALLY CHARGED VOLUMES WITH CYLINDRICAL CONFIGURATIONS. Danilov, V. I.; Puzynin, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated by Jack Kristo (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from report JINR–P–2131. 22p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 19: 39314.

3803 (ORNL–TM–2722) ELECTROMAGNETIC- AND NUCLEAR-CASCADE CALCULATIONS AND THEIR APPLICATION IN SHIELDING AND DOSIMETRY. Aismiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Aug. 15, 1969. 27p. (CONF-691101–4). Dep. CFSTI.

From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

A review paper on recent high-energy accelerator shielding calculations carried out at the Oak Ridge National Laboratory is presented. The subjects considered are electron-photon cascades, photonucleon and photopion production, nucleon-meson cascades, and muon transport. Calculated results are presented and compared with experimental data in each of these categories. (auth)

3804 (PUC–937–371) DESIGN FEATURES OF THE PRINCETON A. V. F. CYCLOTRON FACILITY. Pollock, R. E. (Princeton Univ., N. J. Palmer Physical Lab.). Sept. 1969. 7p. Dep. CFSTI.

Recent operating performance is reported and several features in the design of the accelerator, beam line and laboratory of the Princeton A. V. F. Cyclotron are described. Although construction began of a close copy of the 56 MeV cyclotron at Michigan State University, there were a number of modifications to the machine, and a somewhat different approach to the laboratory layout and beam transport design was adopted. An rf amplifier, outside the vault shielding, drives the dees through tunable half wave transmission lines. Mode separation is obtained with a simple transmission line coupler. The tuning range was extended by a modification of the dee stem inductance. A magnetic channel in the beam extraction system uses coils and laminated iron foil stacks which avoid saturation while reducing the power demand relative to an air core design. The channel is designed for mini-

mum first harmonic perturbation at the critical radius for the $\nu_R = 1$ resonance and for reduction of the first and second radial derivations of the field on the extraction trajectory. Beam energy analysis is achieved with a 90°, 183 cm radius, flat field magnet made double focusing with discrete quadrupoles. Rotating slits and localized shielding in the beam line will permit external bombardments at the full intensity available from the cyclotron. A high resolution, 15 millisteradian spectrograph is under construction. (auth)

3805 (SJC-A-68-3) TABLES OF GREEN FUNCTIONS. Hirakawa, Hiromasa (Tokyo Univ. (Japan). Inst. for Nuclear Study). June 1968. 125p. Dep. CFSTI (U. S. Sales Only).

Tables of Green functions frequently required in accelerator physics and related fields are presented. Regions of practical interest considered include three-dimensional regions in circular cylinders and also between parallel plates, and two-dimensional regions for a circle and also an infinitely long strip. Tables of Green functions of the first and second kinds are presented to six decimal places on the lattice points of variables at intervals of 0.1 for distances and 7.5° for angles. (W.H.K.)

3806 (UCRL-19232) BEVATRON OPERATION AND DEVELOPMENT. 61. January-March 1969. Crebbin, Kenneth C.; Evans, Don M.; Frias, Robert (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1969. Contract W-7405-eng-48. 14p. Dep. CFSTI.

The beam was on for experimenters 81.9% of the scheduled operating time. During this period the Bevatron accelerated 1.9×10^{18} protons. Beams were provided for 12 primary experiments and three primary experiments were completed. The external beam transport magnets have been placed under computer control. This, coupled with new Bevatron main magnet pulsing modes, has greatly increased the flexibility of machine operation and the ability to satisfy simultaneously the needs of a number of experiments. The extraction efficiency, for short beam pulses as required by the bubble chamber, has been doubled by going to an outer-radius target. (auth)

3807 DESIGN OF A COMPACT LIGHTWEIGHT RADIOGRAPHIC LINAC. Whitham, Kenneth; Meyer, Bruce (Varian Associates, Palo Alto, Calif.). Mater. Eval., 27: 232-7(Nov. 1969).

Major advancements in waveguide and electron injector design have resulted in substantial reduction in weight and size and increased reliability and utility of the radiographic linac. These developments are described, and it is explained how they will be incorporated into high-energy radiographic machines suitable for field or in-plant applications. The equipment which resulted from these developments has been designated the Varian Linatron. (auth)

3808 FOCUSING OF ION BEAMS BY A PLASMA LENS. Zhukov, V. V.; Morozov, A. I.; Shchepkin, G. Ya. JETP Lett. (USSR) (Engl. Transl.), 9: 14-16(Jan. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 24-7(Jan. 5, 1969).

Development of plasma lenses which have refractive powers several orders of magnitude higher than ordinary electrostatic or electromagnetic lenses is discussed. Theoretically, plasma lenses should have no limitations on the intensity or density of the focused beam. A schematic diagram of a plasma lens and results of preliminary studies are presented. (W.H.K.)

3809 A NEW TANDEM AT FLORIDA. Champan, K. R. (Florida State Univ., Tallahassee). Phys. Bull. (London), 20: 415-18(Oct. 1969).

An account is given of the new tandem accelerator due for commissioning at the beginning of 1970 at Florida State University, with emphasis on performance characteristics. The importance of tandem van de Graaff accelerators to the study of nuclear reactions and structure is emphasized. Research applications are outlined. (UK)

3810 APPARATUS FOR MEASURING THE ENERGY AND CURRENT OF AN ACCELERATOR ELECTRON BEAM INCLUDING APERTURED INCIDENT AND EXIT ELECTRODES. Motz, Joseph W. (to Secretary of Commerce). U. S. Patent 3,477,023. Nov. 4, 1969. Filed Jan. 16, 1968.

A metal foil and two apertured electrodes disposed on opposite sides of the foil are centered on the axis of an accelerator electron beam. The thickness of the foil, and the geometry and electric potentials of the electrodes, are arranged so that the electrodes selectively collect the secondary electrons emitted from the incident surface of the foil, and the elastically scattered electrons from the exit surface of the foil. The energy of the electron beam is then given by the ratio of the current due to the secondary electrons to the current due to the elastically scattered electrons; and the current of the electron beam is given by the current due to the secondary electrons. (Offic. Gaz.)

3811 NEGATIVE HELIUM IONS FOR TANDEM ACCELERATORS. Main, I. G. (Univ. of Liverpool). Phys. Bull. (London), 20: 419-22(Oct. 1969).

It has been stated that α-particles cannot be accelerated using the charge reversing tandem principle, since He does not form a negative ion. This situation was completely altered by the discovery of means for producing metastable He-ions in beams of μA intensity. This important development is discussed. (UK)

3812 ON A NEW INSTABILITY IN ELECTRON-POSITRON STORAGE RINGS (THE HEAD-TAIL EFFECT). Pellegrini, C. (CNEN, Frascati, Italy). Nuovo Cim., 64A: 447-73(Nov. 21, 1969).

It is shown that a bunched electron or positron beam of a storage ring can become unstable because of an effect not previously considered; the instability is due to the regenerative effect introduced by synchrotron oscillations, which enhances the action on the beam of rapidly decaying electromagnetic signals excited by the beam itself on its surrounding media. The results obtained show that the effect can produce instabilities for small beam currents (in the milliampere range), and that it can be influenced and reduced by properly choosing some parameters of the storage ring. (auth)

3813 SACLAY LINEAR ACCELERATOR. Sorger, Michel. Sci. Progr.-Nature, No. 3413, 341-8(Sept. 1969). (In French).

A description of the Saclay linear accelerator is given. This electron accelerator has a particularly long useful cycle and reaches energies of about 600 MeV. The interest in high-energy electrons, the structure of the Saclay linear accelerator, and experiments with electrons, photons, pions, and muons are discussed. (J.F.P.)

3814 LOS ALAMOS MESON PHYSICS FACILITY ACCELERATOR. Hagerman, D. C.; Jameson, R. A. (Los Alamos Scientific Lab., N. Mex.). J. Microwave Power, 3: 75-9(July 1968).

The Los Alamos Meson Physics Facility (LAMPF) will be a national center for medium energy physics investigations of nuclear structure, providing beams of nucleons and mesons, some ten thousand times more intense than now available. These beams will be generated by impinging an intense beam of protons on a target. The proton beam is generated by a linear accelerator (linac) about 2600 feet long which forms the heart of the facility and incorporates many substantial advances in the state-of-the-art of microwave power technology. The linac operates at 201.25 MHz requiring about 10 MW and 45 MW of peak power respectively, at a high duty factor of 12%. The phase and amplitude of the fields produced must be continuously controlled to within ±1° and ±1% in the presence of 30% load disturbances. (auth) (Canada)

3815 PENNING ION SOURCE FOR MP ACCELERATOR. Heinicke, E.; Baumann, H. (Univ., Heidelberg). Nucl. Instrum. Methods, 74: 229-32(1969).

In addition to our former investigations of the production of negative ions a Penning ion source with radial extraction was developed for utilisation with MP accelerators. A very great number of ion species can be produced by operating with gases or metallic vapours. The operating conditions were improved with respect to the lifetime of the source. The beam quality guarantees a transmission of the negative ions of 90% from the source to the injection into the accelerator. The intensities of the states of charge were measured with best stripper gas for several types of ions as listed in a table. (auth)

3816 THIRD-ORDER THEORY OF ASYMMETRIZED QUADRUPOLE LENSES. Ovsyannikova, L. P. (Ioffe Inst. of Physics and Tech., Leningrad); Yavor, S. Ya.; Koltay, E.; Szabo, Gy. Nucl. Instrum. Methods, 74: 185-90(1969).

Potential distribution and focusing properties of asymmetrized quadrupole lenses with different electrode configurations are treated in third order approximation. The general properties of the field deduced from this treatment completely agree with the data measured in an electrolytic trough. Aberrations induced by the asymmetrization are shown by a numerical example. (auth)

3817 BEHAVIOUR OF DEUTERATED POLYETHYLENE TARGETS ENCLOSED IN CARBON LAYERS. Makosky, L. M.; Hojvat, C. (Univ. of British Columbia, Vancouver). Nucl. Instrum. Methods, 74: 342-4(1969).

The deterioration of thin self-supporting deuterated polyethylene targets with carbon layers on both sides was investigated when bombarded with a ^{3}He beam. The carbon layers significantly increased the yield. (auth)

3818 BEAM MONOCHROMATION SYSTEM FOR BUNCHED BEAM. Ohkubo, Makio (Japan Atomic Energy Research Inst., Tokai). Nucl. Instrum. Methods, 74: 233-5(1969).

A monochromation system which converts the panchromatic and bunched beam to the monochromatic but debunched beam without appreciable increase in the beam emittance is proposed. (auth)

3819 A HIGH RESOLUTION SYSTEM FOR VAN DE GRAAFF ACCELERATORS. Gaarde, C.; Huus, T.; Joergensen, P. B.; Kemp, K. (Univ. of Copenhagen). Nucl. Instrum. Methods, 74: 329-32(1969).

A system is described, which makes it possible to take into account the slow variations (<1 kc/sec) in the energy of a beam from a Van de Graaff accelerator. The relative beam energy is determined by measurements on a small part of the beam in a combined electrostatic and magnetic analysing system. Correction signals from this system can either control the target potential or be recorded simultaneously with other experimental information. (auth)

3820 ELECTRIC DISSOCIATION OF H^- IONS BY MAGNETIC FIELDS. Stinson, G. M. (Univ. of Alberta, Edmonton); Olsen, W. C.; McDonald, W. J.; Ford, P.; Axen, D.; Blackmore, E. W. Nucl. Instrum. Methods, 74: 333-41(1969).

Electric $v \times B$ dissociation of H^- ions moving through a magnetic field has been measured for electric field strengths near 2 MV/cm. The H^- ions were obtained by charge exchange of protons in water vapor and were accelerated to 49.5 MeV by the proton linear accelerator at the Rutherford High Energy Laboratory. Stripped particles were detected using an acoustic spark-chamber. Experimental lifetimes are lower by approximately a factor of two from those predicted by Mullen and a factor of three from those predicted by Hiskes. Measurements also appear inconsistent with those of Cahill et al. (auth)

3821 THE LUCAS HEIGHTS THREE MILLION VOLT ACCELERATOR. Bird, J. R.; Kenny, M. J.; Ritchie, A. I. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). At. Energy Aust., 12: 2-10(July 1969).

The main features of the 3.0 MeV horizontal Van de Graaff are described, emphasizing the various modes of operation available. Rapid change-over can be made from D.C. to microsecond or nanosecond pulsed operation and the beam may be switched to any one of fourteen target stations. Proton and deuteron beams are available and are used mainly for production of neutrons. The accelerator operates for about 6000 hours each year and 75% of this time is used for neutron physics experiments in fission capture and moderation. The remaining time is used by other divisions and by University visitors for ionization, irradiation, microanalysis, and charged particle experiments. (Australia)

3822 DEUTERATED PLASTIC TARGETS FOR NEUTRON GENERATION. Greil, A.; Truetzschler, K.; Weisner, K. (Institut fuer Experimentelle Kernphysik, Dresden). Kernenergie: 12: 294-7(Sept 1969). (In German).

Deuterated plastic targets are described for neutron generation from the $D(d,n)^3He$ reaction. The targets were bombarded by deuterons of $E \lesssim 500$ keV. The ion current density was 10 $\mu A\ cm^{-2}$. Neutron yield and its variation in time were studied. For such targets a simple and low-cost manufacturing with definite composition has been proved. An advantage of the deuterated plastics targets as compared with those of metal deuterides is their smaller loss of energy and lower multiple scattering in the target layer with the same deuterium content. In particular, they are, therefore, suited for monoenergetic neutron generation. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 2512, 3822, 3913, and 3953.

3823 (AAEC/E-199) SOLUTION OF SOME PROBLEMS BY COLLISION PROBABILITY METHODS. Doherty, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1969. 25p. Dep. CFSTI (U. S. Sales Only).

A comparison is made between isotropic collision probability and discrete S_n solutions to some one-dimensional neutron transport problems. Difficulties associated with the application of one or the other method in particular situations are discussed in detail. The S_n method is generally superior in cylindrical and spherical geometries, and the collision probability method is recommended for slab geometry. (auth) (Australia)

3824 (EUR-3621(Pt.2)) INELASTIC NEUTRON SCATTERING AND LATTICE DYNAMICS OF METALS IN QUASI-ION APPROXIMATION. Krebs, K.; Hoelzl, K. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 5, 1969. 142p. Dep. CFSTI (U. S. Sales Only).

On the basis of the pseudo-ion model described in Part I, the following lattice dynamical quantities were calculated: form-factors, effective potentials, phonon densities of state, dynamical structure factors and effective Debye temperatures. Results are presented for 10 cubic metals. Listings of the pertinent FORTRAN-IV programs are given in appendices. (auth)

3825 (ORNL-TM-2740) PROPERTIES OF THE SPECTRAL RADIUS OF THE INTEGRAL TRANSPORT OPERATOR IN SLAB GEOMETRY. Nelson, Paul Jr. (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 23p. Dep. CFSTI.

The governing equation for transport in slab geometry is written in the form $\varphi = C\underset{\sim}{K}\varphi + q$, where φ is the angular flux, q is the source function, and C is the maximum expected number of secondaries emitted per collision. Physical reasoning dictates that the spectral radius, λ_1, of the positive linear integral operator $\underset{\sim}{K}$ should be an eigenvalue of $\underset{\sim}{K}$ and should satisfy $\lambda_1 < 1$. These results are established under minimal assumptions on the data defining the slab material properties. (auth)

3826 COMPLEX BUCKLING AND COMPLEX RELAXATION TIMES IN THE DECAY OF NEUTRON PULSES. Kuscer, Ivan (Cornell Univ., Ithaca, N. Y.). Nucl. Sci. Eng., 38: 175-6(Nov. 1969).

In a theoretical transport description of pulsed-neutron experiments it is necessary to know the exponential decay modes and the spectrum of the decay constants λ. The methods of Bowden and Williams (J. Math. Phys., 5, 1527(1964)) are used to show that λ may be complex for higher spatial modes. (J.W.R.)

3827 COMMENT ON THE CALCULATION OF NEUTRON LIFETIME. Kiefhaber, Edgar (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng., 38: 178-9(Nov. 1969).

It is shown that the usual way of establishing group constants used in calculating the neutron lifetime in critical assemblies may lead to an underprediction of the lifetime. This indicates that the usual explanation for the discrepancy between calculated and measured lifetimes may be in error. (J.W.R.)

3828 ASYMPTOTIC NEUTRON DECAY CONSTANTS FOR BODIES CONTAINING A CENTRAL BLACK REGION. Judge, F. D.; Arnold, L. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 38: 176-8(Nov. 1969).

The asymptotic decay constant is determined for monoenergetic neutrons in spherical bodies containing a central black region. Simple implicit analytic relations for the decay constant are developed using the variational method described earlier and an extension of the equations for first flight escape probability for such bodies presented by Smith and Murray (Nucl. Sci. Eng., 33: 341(1968)). The resultant values are given in graphical and tabular form. (auth)

3829 REMARKS ON THE CALCULATION OF SLOW-NEUTRON CROSS SECTION AND THERMAL SPECTRA IN WATER. Kosaly, G.; Valko, J. (Central Research Inst. for Physics, Budapest). Nukleonik, 12: 237-40(Aug. 1969).

The possibility of finding a middle course between isotropic and anisotropic treatments is discussed. It is shown, that the consideration of the spatial anisotropy of different modes of motion is not equally important. This can be used for some simplification in the calculational routine. Further, the reason for the agreement between Nelkin-type calculations and experimental cross section at low energies, is investigated. (auth)

3830 ANISOTROPIC SCATTERING CORRECTIONS TO THE EIGENVALUES AND EXTRAPOLATED END-POINT IN THE $P_{\tilde{T}}$-APPROXIMATION OF NEUTRON TRANSPORT THEORY. Leribaux, Henri R.; Lee, James H. Jr.; Lozito, Edward J. (Texas A and M Univ., College Station). Nucl. Sci. Eng., 38: 170-2(Nov. 1969).

The spherical harmonics method for treating anisotropic effects in the scattering kernel of neutron transport theory is examined for the nonlinear case. The secular equation for the eigenvalues in the one-velocity p_L-method including anisotropic scattering up to order L is derived. The numerical evaluation of these eigenvalues for the P_3 method is presented for isotropic scattering in the laboratory and center-of-mass systems is presented. (J.W.R.)

3831 NEUTRON SCATTERING FROM URANIUM DIOXIDE. Young, James A. (Gulf General Atomics, San Diego, Calif.). Nukleonik, 12: 205-8(Aug. 1969).

The lattice dynamics of UO_2 were described by a shell model calculation using force constants determined from experiment. This lattice dynamical model is used to compute weighted phonon spectra which are then available to compute the neutron scattering from the incoherent approximation by means of the computer code GASKET. (auth)

3832 METHOD AND APPLICATION OF NEUTRON SCATTERING FOR THE STUDY OF FLUCTUATIONS IN CONDENSED MATTER. Springer, T. (Kernforschungsanlage, Juelich, Ger.); Glaeser, W. pp 153-71 of Electronic Structures in Solids. Haidemenakis, E. D. (ed.). New York, Plenum Press, 1969.

From 2nd Chania Conference, Chania, Greece. See CONF-680663.

An introduction is presented to some important features of the slow neutron scattering method. Some typical, present-day experiments on phonon scattering in crystals, fluctuations in liquids, and magnetic fluctuations close to the Curie temperature are discussed. 56 references. (D.L.C.)

3833 STUDY OF INELASTIC SCATTERING OF SLOW NEUTRONS BY POLYETHYLENE AT TEMPERATURES 290 AND 100°K. Ivanitskii, P. G.; Krotenko, V. T.; Gorbachev, B. I.; Tsybul'nik, A. N. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 14: 1525-8(Sept. 1969). (In Russian).

Results are presented for studies on the dynamics of inelastic scattering of slow neutrons by crystalline polyethylene. The energy of the scattered neutrons was measured by the time-of-flight method simultaneously at eight various angles between 9.5 and 116.5°. A generalized frequency distribution that was derived using the extrapolation method is given for both temperatures. The experimental results were compared with the theoretical models of Tarasov and Wunderlich. (P.C.H.)

3834 PULSE RATE CORRELATION IN DYNAMIC EXPERIMENTS. Fazzolare, Rocco A. (Univ. of Arizona, Tucson). Nucl. Appl. Technol., 8: 84-7(Jan. 1970).

An experimental technique is described that will facilitate the acquisition and analysis of information from dynamic neutron physics experiments. The Fourier transform of a forced oscillating neutron field is determined on-line and presented in a visual display. Crosscorrelation is used to extract the information; the method is based on the utilization of detector pulses in weighting a correlative signal. The time of the measurement and data reduction is considerably reduced as compared with existing methods requiring a multichannel analyzer and a digital computer. Frequency measurements in the range of 10 KHz and above are feasible. (auth)

3835 ON NEUTRON TRANSPORT IN TWO ADJACENT HALF-SPACES WITH ANISOTROPIC SCATTERING. Bowden, Robert L.; McConnell, Benjamin W. (Virginia Polytechnic Inst., Blacksburg). Nukleonik, 12: 269-75(Oct. 1969).

The use of continuity boundary conditions in the solution of the singular integral equation form of the neutron transport equation is illustrated by solving the Milne and uniform isotropic source problems for two adjacent half-spaces. The relation to the normal mode expansion method and its extension to the complex plane is indicated. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 3503, 3515, 3718, 3954, 3972, and 3973.

3836 (AWRE-O-47/69) MEASUREMENT OF (n,2n) AND (n,3n) CROSS SECTIONS AT 14-MeV INCIDENT ENERGY. Mather, D. S.; Pain, L. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Aug. 1969. 27p. Dep. CFSTI (U. S. Sales Only). UK 4s. 0d.

A large liquid scintillation counter was used with a pulsed 14.1-MeV neutron source to measure (n,2n) and (n,3n) cross sections for ^{3}H, ^{3}He, ^{6}Li, ^{7}Li, ^{10}B, ^{11}B, Y, Cu, Pb, and ^{238}U. The measurements are based on the fission cross section of ^{235}U using a new method of flux measurement and $\bar{\nu}$ for ^{252}Cf spontaneous fission for the detector efficiency calibration. (auth)

3837 (UCLA-10-P-16-15) KINEMATICALLY INCOMPLETE AND COMPLETE STUDIES OF THE BREAKUP OF ^{4}He BY 47-MeV PROTONS. Technical Report P-84. Rogers, Joel Guild (California Univ., Los Angeles. Dept. of Physics). June 1969. Contract AT(11-1)-Gen-10. 112p. Dep. CFSTI.

The reactions induced by 47-MeV protons on ^{4}He were investigated in a kinematically incomplete experiment, by observing triton and deuteron spectra, and in a kinematically complete experiment, by observing correlated triton-proton spectra. The reactions studied included ^{4}He(p,d)^{3}He, ^{4}He(p,^{3}He)pn, and ^{4}He(p,t)pp. Natural helium gas targets were employed. The single counter (kinematically incomplete) observations were performed with a dE/dx – E counter telescope from which two-dimensional pulse height arrays were stored by an on-line computer. Spectra and angular distributions were analyzed using the Watson–Migdal Theory and direct reaction theory of Dar, respectively. The kinematically complete experiment was performed using two counter telescopes, one to observe ^{3}He and tritons from the reactions ^{4}He(p,^{3}He p)n and ^{4}He(p,tp)p and one to observe the correlated protons. Data were stored by the computer in a four dimensional form by serial listing on magnetic tape of four linear signals from each event. Computerized analysis of these data is described. Proton spectra showed strong enhancements from the nucleon–nucleon final state interactions, either pp or np, which were found to be in good agreement with the predictions of the Watson–Migdal Theory. A Chew–Low type extrapolation procedure was used to extract the np singlet scattering length giving the best fit to the proton spectrum from ^{4}He(p,^{3}He p)n; this scattering length was in agreement with the value from np free scattering. The triton spectra showed peaks due to a sequential reaction process via the continuum resonance states of the ^{4}He system. These enhancements could be identified with previously observed ^{4}He levels of known spin and parity assignments. (auth)

3838 A SEARCH FOR AN EXCITED STATE IN ^{4}He NEAR 30 MeV AND AN OPTICAL-MODEL ANALYSIS OF ALPHA-PARTICLE SCATTERING. Weisser, David Calvin. Minneapolis, Univ. of Minnesota, 1968. 133p.

Thesis.

Excited states in ^{4}He were observed via the reaction ^{6}Li(d,α)^{4}He. No evidence was found for states with excitation energies of 24 to 35 MeV. A technique for making lithium targets by encapsulation in a sputtered nickel foil is described. A charged particle identification system using an on-line computer to process signals from a passing counter and a stopping counter is also described. An optical-model analysis was performed on data from α-particle scattering on ^{58}Ni at 64.3, 50.2, and 21.08 MeV and on ^{54}Fe at 64.3 MeV. The discrete and continuous real potential ambiguities are thoroughly investigated. The surface sensitivity of the scattering is studied and reveals that the scattering is determined by the potential at r > 7 F. Data quality criteria are also discussed. (Disser. Abstr.)

3839 NEUTRON CAPTURE ON MOLECULAR HYDROGEN. Rietschel, H.; Schott, W.; Fink, J.; Kapulla, H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng., 38: 180(Nov. 1969).

In order to check the effects of chemical binding on neutron capture by protons, the γ spectra for the p(n,γ) reaction was measured using cold neutrons and a liquid hydrogen target. It was found that any difference in neutron capture between ortho- and para-H_2 lies within 3% in good agreement with the theoretically predicted results. (J.W.R.)

3840 MEASUREMENT OF THE ANGULAR DISTRIBUTION OF ^{4}He(p,d)^{3}He, ^{4}He(p,^{3}He)pn, AND ^{4}He(p,t)pp REACTIONS. Rogers, J. G. (Univ. of California, Los Angeles); Cameron, J. M.; Epstein, M. B.; Paic, G.; Tomas, P.; Richardson, J. Reginald; Verba, J. W.; Doherty, P. Contract AT(11-1)-Gen-10. Nucl. Phys., A136: 433-45(1969).

The angular distribution of the reaction ^{4}He(p,d)^{3}He at 47 MeV was measured over the center-of-mass angular range of 12 to 166°. Also the angular distributions of the reactions ^{4}He(p,^{3}He)pn and ^{4}He(p,t)pp in the region of the nucleon-nucleon final state interaction were measured at the same bombarding energy over an angular range of 7.5 to 50.0° in the laboratory. The ^{3}He and triton energy spectra are also presented and Watson–Migdal fits to these data in the region of the nucleon-nucleon final state interaction are shown. (auth)

3841 NEUTRON–NEUTRON SCATTERING LENGTH FROM NEUTRON SPECTRA OF THE REACTION ^{2}H(n,2n)^{1}H. Graessler, H.; Honecker, R. (Technische Hochschule, Aachen). Nucl. Phys., A136: 446-58(1969).

Low-energy neutron spectra from the reaction ^{2}H(n,2n)^{1}H were measured at a neutron bombarding energy of 14 MeV for fixed energy thresholds of the break-up protons. By choosing a scattering angle of 70° for the neutrons, only events were recorded, for which in the c.m. system a forward-going proton corresponds to backwards emitted neutrons with low relative momentum. Configurations of this kind are governed by n-n final-state interactions. The reaction took place in a deuterated scintillator which served to fix the proton energy threshold. The measured neutron time-of-flight spectra for three different proton thresholds of 8.5, 9.5 and 10.5 MeV were analyzed by a Monte Carlo method using the Born approximation for the calculation of the break-up cross section. A value of $a_{nn} = -16.2 \pm 2.2$ fm was found to give best agreement with the experiment. (auth)

3842 PROTON–PROTON FINAL STATE INTERACTION IN THE p + ^{3}He REACTION. Chang, C. C. (Univ. of Southern California, Los Angeles); Bar-Avraham, E.; Forster, H. H.; Kim, C. C.; Tomas, P.; Verba, J. W. Contracts AT(04-3)-136; AT-(11-1)-Gen-10. Nucl. Phys., A136: 337-52(1969).

The proton-proton final state interaction was studied using the ^{3}He + p → d + p + p reaction both in single counter, kinematically "incomplete" (E_p = 30.2 and 46.0 MeV) and angular correlation, kinematically "complete" (E_p = 46.5 MeV) experiments. In the single counter experiment the angular dependence of the final state interaction was determined between ϑ_{lab} = 10 and 50°. A Watson–Migdal calculation was used to fit the experimental deuteron spectra near the high-energy cutoff; the calculated distributions obtained for a choice of reasonable parameters were found to be wider at the peak than the experimental data indicated. The angular correlation experiments were performed at counter settings at which the contributions from p-p final state interaction were expected to be relatively large; these particular experiments indicated: that p-p final state interaction contributes significantly to the three-body process and, that the proton pair is preferentially emitted with an internal energy of $E_{2p} \approx 0.4$ MeV. A Watson–Migdal calculation applied to the angular correlation experiments gave good agreement with the experimental results. An explanation for the difference in fitting single counter or angular correlation experiments is given. (auth)

3843 STUDY OF THE ELASTIC SCATTERING ^{4}He(d,d)^{4}He IN THE S MATRIX FORMALISM. Kraus, L.; Linck, I.; Magnac-Valette, D. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys., A136: 301-10(1969). (In French).

The ^{4}He(d,d)^{4}He differential cross section between 0.9 and 9 MeV is analyzed in the framework of S-matrix theory. Different parametrizations of the collision matrix have been tried. The values of the resonance parameters of the T = 0 d-wave triplet in ^{6}Li are determined. The ratio $\eta_n = (\Gamma_c + \Gamma_{cn})/\Gamma_n$ and the deviation from unitarity of the collision matrix are derived for the $J^{\pi} = 3^{+}$ level. (auth)

3844 π^{-}-NUCLEUS SCATTERING LENGTHS. Seki, Ryoichi (Univ. of Georgia, Athens. San Fernando Valley State Coll., Northridge, Calif.). Phys. Rev. Lett., 23: 1000-3(Oct. 27, 1969).

S-wave π^{-}-nucleus scattering lengths for nuclei of mass number 3 to 24 are extracted from all available 2P-1S transition-energy data in π^{-}-mesonic atoms. (auth)

3845 COMPARATIVE ANALYSIS OF EXPERIMENTAL DATA ON THE REACTIONS (d,t), (^{3}He,d), AND (p,d), (d,n). Borbei, L.; Dolinskii, E. I. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 10: 299-308(Aug. 1969). (In Russian).

Data on differential cross sections of the reactions (p,d) and (d,t), (d,n) and (^{3}He,d) on light nuclei, as well as of the D(d,p)T reaction, are analyzed in the framework of the peripheral model in the pole approximation. The peripheral model describes the experiment

rather well. New information about the amplitudes of virtual decays $t \rightarrow d + n$ and $^3He \rightarrow d + p$ on mass surface is obtained from the analysis. (auth)

3846 DIFFERENTIAL CROSS SECTIONS FOR THE REACTION $^4He(\gamma,p)^3H$ FROM 55 TO 165 MeV. Stenberg, Charles Gustave. Urbana, Ill., Univ. of Illinois, 1968. 127p.
Thesis.

Differential cross sections were measured for the reaction $^4He(\gamma,p)^3H$ for incident photons of 55 to 165 MeV. Outgoing protons and tritons from a low temperature ^4He target were detected in coincidence at three angular settings in the laboratory: (θ_P,θ_T) = (59.5, 106°), (88.5, 75°), and (118, 47.5°). The triton detection system consisted of three semiconductor detectors followed by a plastic scintillator. The proton detection system consisted of four plastic scintillators and was large enough to collect all protons correlated with tritons in the triton system. The pulses from the calibrated detectors were used to identify the particles and measure their energies. The results show an exponential decrease in the differential cross sections with increasing gamma ray energy with possible leveling off at the region of pion threshold. The angular distribution of the protons is peaked more strongly forward as the energy increases. A simple calculation relates the differential cross sections at the several angles to a common function of the proton or tritium momentum. Results of this calculation are compared with the data. (Disser. Abstr.)

3847 SOFT-CORE POTENTIALS IN THE TRITON. Van Dijk, W.; Preston, M. A.; Willis, J. B. (McMaster Univ., Hamilton, Ont.). Nucl. Phys., A137: 331-47(1969).

The triton binding energy was calculated for several soft-core nucleon–nucleon potentials using the Rayleigh-Ritz variational method. When Gaussian-type trial functions are employed, it is found that such functions can easily be decomposed into a sum of terms, each of which has pure two-body LSJ dependence. This is a necessary feature in order to do the calculation with the Reid soft-core potential. The calculations were done for the Bressel and Reid potentials. In order to test the accuracy of the trial function, the attractive Pease-Feshbach potential and the central soft-core Coester-Yen potential were also used. It was found that regardless of the number of terms, the superposition of Gaussians is inferior to exponential-type trial functions. Realizing the deficiency of Gaussian-type trial functions, one can consider that the modern realistic soft-core potentials give results consistent with binding albeit with large uncertainty limits. The Coester-Yen potential, although it is "unrealistic" in the sense that it has no tensor part, yields a binding energy and radius of the triton which are in close agreement with experiment. (auth)

3848 MODEL DEPENDENCE OF α_{nn}, pp BREMSSTRAHLUNG, AND THE BINDING ENERGY OF NUCLEAR MATTER. Miller, M. D. (Michigan State Univ., East Lansing); Sher, M. S.; Signell, P.; Yoder, N. R.; Marker, D. Phys. Lett., 30B: 157-9 (Sept. 29, 1969).

Hard-core, soft-core, finite-core, short-range P^2-dependent, and intermediate-range P^2-dependent potentials with one-pion-exchange tails are precisely matched to the 0 to 330 MeV $^1S_0$ data. Adding the Hamada–Johnston potential for other states when necessary, predictions are made for the neutron–neutron scattering length, proton–proton bremsstrahlung, and the binding energy per nucleon in nuclear matter. Of these, only the nuclear matter binding energy shows significant model dependence. (auth)

3849 THRESHOLD ELECTRODISINTEGRATION OF DEUTERON AND THE $^1S_0$ RESONANCE. Bosco, B. (Univ., Cagliari, Italy. International Center for Theoretical Physics, Trieste, Italy); Mosconi, B.; Varcaccio, G. Phys. Lett., 30B: 136-9 (Sept. 29, 1969).

The recent data on the electrodisintegration of deuteron at large scattering angle of the electron near the threshold obtained at Saskatoon are analyzed with the dispersive approach. It is shown that in the effective range approximation the dominating effect is the $^1S_0$ virtual resonance of the proton-neutron system. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 3492, 3503, 3507, 3803, 3836, 3844, 3845, 3953, 3954, 3962, and 3965.

3850 (CEA-CONF-1333) INTENSITY OF THE (2p-1t) COMPONENT IN THE EXCITED STATES OF ^{17}O. Mermaz, M. C.; Lemaire, M.-C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Scheurer, J. N. (Bordeaux Univ. (France). Laboratoire de Physique Nucleaire); Seth, K. K. (Northwestern Univ., Evanston, Ill.). [1969]. 1p. (In French). (CONF-690804-11). Dep. CFSTI (U. S. Sales Only).
From International Conference on Properties of Nuclear States, Montreal, Canada.

The proton angular distributions from the $^{15}N(^3He,p)^{17}O$ reaction were measured from 5 to 70°. A diagram is given of the relative excitation intensities of ^{17}O at an angle of 15°. The fact that only two levels 5.71 MeV $\frac{1}{2}^-$ and 7.37 MeV $\frac{5}{2}^-$ are strongly excited in the first part of the spectrum are confirmation of the theoretical hypothesis that the first excited states of negative parity should have their (1p-0t), (2p-1t) configurations strongly mixed with higher order configurations. Above 7.37 MeV the 2p-1t force becomes more important in the spectrum. (J.S.R.)

3851 (NP–18036) INVESTIGATION OF (γ, p) REACTIONS IN ^7Li USING A BEAM OF QUASI-MONOCHROMATIC AND POLARIZED PHOTONS. Antuf'ev, Yu. P.; Zhebrovskii, Yu. V.; Kolesnikov, L. Ya.; Kuz'menko, V. S.; Miroshnichenko, I. I.; Rubashkin, A. L.; Sorokin, P. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 10p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The (γ, p) reaction in ^7Li was investigated in a beam of coherent, linearly polarized bremsstrahlung obtained by slowing down electrons on a diamond single crystal. The measured sensitivity of the (γ, p) reaction in ^7Li to photon polarization agrees qualitatively with that for processes of the photoproduction of ions on free nucleons. The results show that proton yield in the photodisintegration of nuclei for energies and angles corresponding to the kinematics of the photoproduction of π-mesons on free nucleons is basically caused by a meson mechanism of photon interaction. (auth)

3852 (ORO–2791-29) GAMMA-RAY YIELD FROM NEUTRON INTERACTIONS WITH ^{10}B. Nellis, Donald O.; Tucker, W. E.; Morgan, Ira L. (Texas Nuclear Corp., Austin). [1968]. 30p. Dep. CFSTI.

Cross sections for gamma rays produced by neutron bombardment of ^{10}B were measured between 50 keV and 5 MeV and 14.8 MeV. Special emphasis was placed on measurements of the 0.478-MeV gamma ray from the $^{10}B(n,\alpha)^7Li$ reaction. Most of the unbounded levels in ^{10}B did not emit any observable gamma rays. The 0.478-MeV gamma-ray production cross section showed a departure from 1/v above a neutron energy of 100 keV. (auth)

3853 (UCLA–10-P-18-14) PROTON TOTAL REACTION CROSS SECTIONS FOR LIGHT NUCLEI BETWEEN 24 AND 46 MeV. Technical Report P-83. McGill, William F. (California Univ., Los Angeles. Dept. of Physics). Sept. 1969. Contract AT(11-1)-Gen-10. 94p. Dep. CFSTI.

Proton total reaction cross sections for ^9Be, ^{12}C, ^{16}O, ^{19}F, ^{27}Al, and natural Si were measured at 24 to 46 MeV with an uncertainty of 2 to 3%. The data were compared with optical-model calculations in the same energy range. The optical-model predictions were found to be in excellent agreement with measured values for silicon and aluminum. The predictions for oxygen and carbon were fair while those for beryllium were poor. (J.W.R.)

3854 PRODUCTION RATE OF ^{10}Be FROM OXYGEN SPALLATION. Goel, P. S. (Indian Inst. of Tech., Kanpur). Nature (London), 223: 1263-4(Sept. 20, 1969).

One of the possible reaction products from the spallation of oxygen with high energy protons is ^{10}Be, of half-life 2.7×10^6 yr., and a knowledge of the cross-section for this reaction is of considerable importance in cosmic ray physics and nuclear astrophysics. Direct measurements for this cross-section disagree by a factor of about 8. Very reliable and independent evidence exists, from the analysis of data on the measured concentration of cosmic ray produced ^{10}Be in stone meteorites, that the cross-section for the production of this nuclide from oxygen by cosmic rays is close to the value of (1.8 ± 0.6) mb reported by Honda and Lal (Nucl. Phys. 51: 363(1964)). From data on the concentration of ^{10}Be and ^3H in stone meteorites the cross-section of ^{10}Be production is calculated as (2.0 ± 0.5) mb for the energy range 0.4 to 3 GeV. Additional support for the 2 mb value comes from measurements of ^7Be and ^{10}Be by Moeller and Wagner (Z. Naturforsch. 23A: 1221(1968)) in a terrestrial rock exposed for a long period to cosmic rays. (UK)

3855 POLARIZATION OF PROTONS ELASTICALLY SCATTERED FROM LIGHT NUCLEI. Prior, Richard Marion. Gainesville, Fla., Univ. of Florida, 1968. 121p.
Thesis.

The polarization of protons elastically scattered from carbon, magnesium and beryllium was measured using the double-scattering technique. Elastic scattering from helium at 90 degrees was used as the polarization analyzer, in a polarimeter containing surface barrier detectors. Self-supporting foils of carbon, magnesium and beryllium in their natural isotopic abundances were used as the first scattering targets. Angular distribution measurements of polarization and cross section were made for $^{12}C(p,p)^{12}C$ at 3.4 MeV. A phase shift analysis of these data gives results in good agreement with the extrapolation of phase shifts from lower energies. The polarization for $^{24}Mg(p,p)^{24}Mg$ was measured as a function of energy from 2.7 to 4.1 MeV at laboratory angles of 50, 80, and 120 degrees. Anomalous behavior was observed. (Disser. Abstr.)

3856 NEW RESULTS IN DELAYED PROTON EMISSION. Verrall, Ronald Ian. Montreal, McGill Univ., 1968. Thesis.

The previously unidentified nuclei ^{9}C, ^{25}S, ^{33}Ar, and ^{37}Ca were observed to decay with the delayed emission of protons. Lifetimes of the nuclei and the proton energies involved were recorded. Using the relative intensities of the proton peaks, log ft values were measured for a number of the β^+ decay branches of the nuclei ^{21}Mg, ^{25}Si, ^{29}S, ^{33}Ar, and ^{37}Ca. A counter telescope for the observation of low energy protons (down to 0.8 MeV) in a large gamma ray background was designed and built, using a thin proportional counter as the dE/dx detector. With this telescope, the energies and intensities of new low energy proton peaks following the decay of ^{21}Mg and ^{29}S were measured. Log ft values for the β^+ transitions were estimated. The known nucleus ^{40}Sc was discovered to be a delayed proton precursor. Energies and relative intensities of eighteen peaks, all below 4 MeV, were measured. (Disser. Abstr.)

3857 DEUTERON INDUCED REACTIONS ON ^{14}N. Porto, V. Gomes (Univ., Sao Paulo, Brazil); Ueta, N.; Douglas, R. A.; Sala, O.; Wilmore, D.; Robson, B. A.; Hodgson, P. E. Nucl. Phys., A136: 385-413(1969).

The absolute differential cross sections for the reactions $^{14}N(d,p)$ ^{15}N (E_x = 5.28, 5.31, 6.33, 7.16, 7.31, 7.57 and 8.32 MeV), $^{14}N(d,\alpha)$ ^{12}C (E_x = 0, 4.433, 7.656 and 9.64 MeV) and for the elastic scattering of deuterons on ^{14}N were measured in the energy range 1.0 $\leq E_d \leq$ 3.1 MeV. These data are analyzed using the optical model and the Hauser–Feshbach and DWBA theories. (auth)

3858 MASS NUMBER DEPENDENCE OF THE (γ,p) AND (γ,d) REACTION CROSS SECTIONS AT PHOTON ENERGIES 700 AND 1200 MeV. Antuf'ev, Yu. P.; Agranovich, V. A.; Ganenko, V. B. Kuz'menko, V. S.; Miroshnichenko, I. L.; Sorokin, P. V. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 14: 248-53(Feb. 1969). (In Russian).

The cross sections of the (γ,p), (γ,d) reactions were investigated. ^{7}Li, ^{9}Be, ^{12}C, ^{28}Si, ^{63}Cu, ^{98}Mo and ^{181}Ta targets were irradiated with the bremsstrahlung of 700 and 1200 MeV maximum energy from the Kharkov PhTI Ac. Sci. UkrSSR linear accelerator. The photoprotons and deuterons were detected by the scintillation telescope at 30, 60 and 120° with the beam. Possible mechanisms of the protons and deuteron photoproduction are discussed. The qualitative agreement of A dependence of the cross sections is observed with a suggestion on the meson mechanism for these reactions. (auth)

3859 PAIRING-PLUS-QUADRUPOLE CALCULATIONS OF THE EVEN-PARITY STATES OF ^{16}O AND ^{20}Ne. Jaeger, H. U. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A136: 641-8(1969).

A shell-model calculation taking into account 4 particles in the shells $1p_{\frac{1}{2}}$, $1d_{\frac{5}{2}}$, $2s_{\frac{1}{2}}$, $1d_{\frac{3}{2}}$ and using a pairing (J = 0,1)-plus-quadrupole Hamiltonian gives a unified description of the even-parity states of ^{20}Ne and ^{16}O. Apart from the known 4p-4h band the other low-lying even-parity states of ^{16}O appear to have a 2p-2h structure. The states of ^{16}O interpreted recently as an 8p-8h band should contain a perceptible 4p-4h component. (auth)

3860 PARTICLE-HOLE STATES IN ^{16}O AND ^{40}Ca. Perez, S. M. (Nuclear Physics Lab., Oxford). Nucl. Phys., A136: 599-608(1969).

The negative parity levels of ^{16}O and ^{40}Ca are investigated in terms of the particle-hole model. The optimum parameters of a finite-range spin and t-spin dependent interaction, including a Coulomb term are determined. The single-particle wave functions are computed in a finite Saxon-Woods well, with the parameters adjusted to fit the energy levels of neighbouring odd-A nuclei. The effective interactions obtained by a least squares fit to the energy levels of each nucleus are similar supporting the phenomenological approach to the problem. The sensitivity of the averaged results to the various components of the force is investigated and it is found that the results are insensitive to the S = 0, T = 0 component of the two-body interaction. (auth)

3861 A DOUBLE-SCATTERING MODEL FOR THE $^{6}Li(^{16}O,d)^{20}Ne$ REACTION. Cheon, Il-T.; Sen Gupta, H. M. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys., A136: 567-76(1969).

A double-scattering model within the framework of the cluster model in nuclei is proposed for the $(^{16}O,d)$ reaction in ^{6}Li; it is thereby possible to account for the forward peak in experimental angular distribution. All the interactions in the formalism were considered to be of the harmonic-oscillator type, and for simplicity, the problem was treated in terms of the plane wave Born approximation. (auth)

3862 STUDY OF $(\alpha,2\alpha)$ REACTIONS ON ^{6}Li, ^{7}Li, AND ^{9}Be AT 55 MeV. Pizzi, J. R.; Gaillard, M.; Gaillard, P.; Guichard, A.; Gusakow, M.; Reboulet, G.; Ruhla, C. (Univ., Lyon). Nucl. Phys., A136: 496-512(1969). (In French).

The $(\alpha,2\alpha)$ reactions on ^{6}Li, ^{7}Li and ^{9}Be targets induced by 55 MeV α-particles are studied in a coplanar geometry by two-dimensional energy analysis. Experimental results are obtained by two methods: angular correlations and energy sharing at a fixed angle. A PWIA interpretation is given, the relative motion being described either by an oscillator function or by a Hankel function. Free $\alpha\alpha$ scattering cross sections are chosen as interaction cross sections. The impulse distributions of the α-clusters and the clustering probabilities are deduced from this analysis. (auth)

3863 PION CAPTURE ON ^{12}C WITH EMISSION OF NEUTRON PAIRS. Cheshire, D. L.; Sobottka, S. E. (Univ. of Virginia, Charlottesville). Phys. Lett., 30B: 244-5(Oct. 13, 1969).

The energy spectra of neutron pairs from the $^{12}C(\pi^-,2n)^{10}B$ reaction were measured. The data disagree with the theory for pion capture from 2P atomic states but agree well for capture from 1S atomic states. (auth)

3864 THE 29.5 MeV DIPOLE STATE OF ^{12}C. Owen, D. G.; Spicer, B. M. (Univ. of Melbourne). Phys. Lett., 30B: 242-3 (Oct. 13, 1969).

The $^{12}C(\gamma,n\alpha)^{7}Be$ cross section was measured, and shows a peak at 29.5 MeV. This state, already seen in the $^{12}C(\gamma,p_0)$ and $^{12}C(\gamma,n)$ cross sections, is discussed in terms of particle-hole configurations. (auth)

3865 MAGNITUDE OF THE VECTOR COUPLING CONSTANT EDUCED FROM RECENT BETA DECAY MEASUREMENTS. Freeman, J. M.; Robinson, D. C.; Wick, G. L. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 30B: 240-1 (Oct. 13, 1969).

Values of the vector coupling constant calculated from measurements of a number of pure Fermi and mirror transitions are compared. A new result for ^{10}C decay is more consistent with other values but there is a large discrepancy in the case of ^{35}Ar. (auth)

3866 EFFECTS OF INTERFERENCE TERMS IN SEQUENTIAL REACTIONS. Goulard, G. (Univ. Laval, Quebec). Phys. Lett., 30B: 216-17(Oct. 13, 1969). (In French).

A sequential mechanism is assumed to calculate the differential cross section for the reaction $^{11}B(p,\alpha)2\alpha$. An important contribution comes from the interference terms which arise because of the identity of the three final particles. (auth)

3867 ANGULAR DISTRIBUTIONS OF THE REACTION $^{12}C(d,p)^{13}C$ BELOW 2 MeV. Borbely, I.; Dolinszky, T.; Eroe, J.; Hrehuss, G. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 26: 269-83(1969).

Excitation functions of the $^{12}C(d,p_0)$ and $^{12}C(d,d)$ reactions were measured at 90° in the range E_d = 900 to 2000 keV in 10 keV steps. Angular distributions of the $^{12}C(d,p_0)^{13}C$ reaction were measured in steps of 25 keV. The experimental data are interpreted in terms of interfering compound levels. Interference phenomena suggest additional new levels in ^{14}N. (auth)

3868 HIGH SPIN STATES IN ^{19}F. Jackson, K. P.; Ram, K. Bharuth; Lawson, P. G.; Chapman, N. G.; Allen, K. W. (Oxford Univ.). Phys. Lett., 30B: 162-4(Sept. 29, 1969).

A new level at 4.648 MeV was discovered in ^{19}F and shown to have a spin-parity assignment $^{13}/_{2}^{+}$. The mean life of this level has been measured to be 2.1 ± 0.4 ps in good agreement with shell model calculations. (auth)

3869 NUMERICAL STUDY ON THE VALIDITY OF DWBA FOR (d,p) REACTIONS. Ichimura, M. (Tokyo Univ.); Kawai, M.; Ohmura, T.; Imanishi, B. Phys. Lett., 30B: 143-6(Sept. 29, 1969).

The S-matrix of (d,p) reactions was calculated by (a) Coulomb wave Born approximation (CWBA), (b) DWBA and (c) coupled channels method (CC): The angular momentum space can be divided into three regions according as (I) CWBA = DWBA = CC, (II) CWBA ≠ DWBA = CC and (III) CWBA ≠ DWBA ≠ CC. (auth)

3870 TEST OF THE BARSHAY–TEMMER THEOREM FOR THE REACTION $^{10}B + \alpha \rightarrow {}^{7}Li + {}^{7}Be$. Fortune, H. T.; Richter, A.; Zeidman, B. (Argonne National Lab., Ill.). Phys. Lett., 30B: 175-8(Sept. 29, 1969).

The Barshay–Temmer theorem was tested via the reactions $^{10}B(\alpha,{}^{7}Li_{g.s.}){}^{7}Be_{g.s.}$ and $^{10}B(\alpha,{}^{7}Be_{g.s.}){}^{7}Li_{g.s.}$ at $E_\alpha = 46$ MeV. In order to minimize experimental uncertainties, angular distributions for both reactions were measured simultaneously; the symmetry required by the theorem was shown by the fact that the ratio between the intensities of the outgoing particles at a fixed angle is unity within the experimental uncertainties. This implies an extreme similarity of the wave functions of the ground-state isobaric doublet ^{7}Li-^{7}Be and provides a simple test of the charge independence of nuclear forces. (auth)

3871 POLE DOMINANCE IN THE REACTION $^{6}Li(^{16}O,d)^{20}Ne$. Jameel, M. (International Atomic Energy Agency, Trieste, Italy). Phys. Lett., 30B: 155-6(Sept. 29, 1969).

A simple pole-dominance model is shown to give a satisfactory explanation of the observed angular distribution in the reaction $^{6}Li(^{16}O,d)$ leading to ^{20}Ne in the ground state. (auth)

3872 OPEN-SHELL RPA CALCULATIONS FOR THE GIANT-DIPOLE EXCITATIONS OF ^{12}C. Rowe, D. J.; Wong, S. S. M. (Univ. of Toronto). Phys. Lett., 30B: 147-9(Sept. 29, 1969).

The RPA is extended to open-shell nuclei, in the equations of motion formalism, and applied to the $J^\pi = 1^-$, T = 1 excitations of ^{12}C. It is found that a mixed configuration ground state results in a splitting of the giant photoresonance. (auth)

3873 GIANT DIPOLE EXCITATIONS OF ^{12}C IN THE OPEN SHELL TAMM–DANCOFF APPROXIMATION AND IN THE INTERMEDIATE-COUPLING SHELL MODEL. Wong, S. S. M.; Rowe, D. J. (Univ. of Toronoto). Phys. Lett., 30B: 150-2 (Sept. 29, 1969).

Particle–hole and detailed shell model calculations were performed for the giant dipole excitations of ^{12}C. It is found that the particle–hole approximation gives the correct gross structure of the photo-resonance provided the particle–hole excitations are referred to the intermediate coupling ground state rather than to the unrealistic closed $1p_{\frac{1}{2}}$-shell. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 3492, 3503, 3803, 3836, 3838, 3844, 3853, 3855, 3856, 3858–3860, 3865, 3869, 3953, 3954, 3962, 3970, 3975 and 3979.

3874 (CEA-CONF-1327) ELECTROMAGNETIC DE-ENERGIZATION OF SEVERAL ENERGY LEVELS OF ^{58}Ni. Beuzit, P.; Delaunay, J.; Fouan, J. P.; Ronsin, H. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 1p. (In French). (CONF-690804-3). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

The $(p,p'\gamma)$ reaction at proton energy of 12 MeV was used to study the nature of the first excited levels of ^{58}Ni by determining their mode of electromagnetic deexcitation. In the framework of the vibrational image the levels of ^{58}Ni can be classified into the 1-phonon level at 1.453 MeV (2^+), the 2-phonon levels at 2.457 (4^+), 2.771 (2^+), and 2.941 MeV (0^+), and the 3-phonon levels at 3.775 MeV (3^+), 5.064 MeV, and 5.171 (6^+). A very excited level was obtained near 5.6 MeV with a spin of 4^+ or 5^-. The possible existence of a very tight doublet (4 keV) was revealed. A scheme compatible with the experiences with this doublet is presented. (J.S.R.)

3875 (CEA-CONF-1328) MULTIPLETS AT 4.10 AND 4.44 MeV OF EXCITATION IN ^{42}Ca. Tellez, A.; Ballini, R.; Delaunay, J.; Fouan, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 1p. (In French). (CONF-690804-13). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

The reactions $^{42}Ca(p,p'\gamma)^{42}Ca$ and $^{41}K(^{3}He,d\gamma)^{42}Ca$ were studied at incident energies of 12 and 18 MeV, respectively. The $(^3He,d)$ measurement showed the four levels T = 2 of the proton configuration $(f_{\frac{7}{2}},d_{\frac{3}{2}}^{-1})$ at the energies of 9.75, 9.85, 10.00, and 10.45 MeV. The T = 2 levels are deexcited principally toward the T = 1 levels of the same configuration. The multiparametric recording and the bidimensional analysis of the coincidences of the $(p,p'\gamma)$ measure showed a doublet and a triplet existing at 4.10 and 4.44 MeV. The deexcitation schemes of the members of these multiplets and the spins and parities attributed to them by taking into consideration those established at these energies by different reactions are tabulated. (J.S.R.)

3876 (CEA-CONF-1332) STUDY OF THE REACTIONS (p,d) ON THE NUCLEI OF ^{57}Fe, ^{61}W, ^{91}Zr BY MEANS OF POLARIZED PROTONS. Escudie, L.; Faivre, J. C.; Gosset, J. M.; Lombard, R. M.; Mayer, B.; Thirion, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Kamitsubo, H. (Institute of Physical and Chemical Research, Tokyo (Japan)). [1969]. 1p. (In French). (CONF-690804-10). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

The cross sections and the asymmetries, from 15 to about 150°, were measured for the reactions $^{61}Ni(p,d)^{60}Ni$ ($l_n = 1$, $j_n = \frac{3}{2}$) at 16.6 MeV, $^{57}Fe(p,d)^{56}Fe$ ($l_n = 1$, $j_n = \frac{1}{2}$), $^{57}Fe(p,d)^{56}Fe^*$ (2^+, $E_x = 0.847$ MeV) at 17.3 MeV, and $^{91}Zr(p,d)^{90}Zr$ ($l_n = 2$, $j_n = \frac{5}{2}$) at 24.5 MeV. The cross sections and polarizations for the elastic scattering of protons on these nuclei were measured simultaneously. Optical potentials, taking into account the experimental data, were determined for DWBA calculations. The cross section for the $^{57}Fe(p,d)^{56}Fe^*$ reaction is much better reproduced with an equal mixture of $l_n = 1$, $j_n = \frac{3}{2}$ and $l_n = 3$, $j_n = \frac{5}{2}$ than with pure $l_n = 1$. The asymmetry is also described better by this mixture, but much less significantly. (J.S.R.)

3877 (CEA-CONF-1334) INVESTIGATION OF THE STATES (2p-1t) OF ^{29}Si BY MEANS OF THE REACTION $^{27}Al(^{3}He,p)^{29}Si$. Mermaz, M. C.; Lemaire, M.-C.; Fernandez, B. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 1p. (In French). (CONF-690804-12). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

The 18-MeV ^{3}He ion beam at Saclay was used to study the reaction $^{27}Al(^{3}He,p)^{29}Si$. The following analogous states were identified: 8.270 ± 0.020 MeV $\frac{5}{2}^+$, 9.634 ± 0.030 MeV ($\frac{1}{2}^+$), 10.000 ± 0.030 MeV, and 10.460 ± 0.030 MeV. The angular distribution of the first T = $\frac{3}{2}$ was calculated with a form factor corresponding to the transfer of the neutron-proton pair on the orbit $2s_{\frac{1}{2}}$. The good agreement between the calculated and experimental cross section suggests, for this state, a strong component $(1d_{\frac{3}{2}})^{-1}(2s_{\frac{1}{2}})^2$. The ground state of spin $\frac{1}{2}^+$ has an angular distribution L = 2, which signifies that the proton is transferred into the $1d_{\frac{3}{2}}$ hole and the neutron on the orbit $2s_{\frac{1}{2}}$. The levels 1.273 MeV $\frac{3}{2}^+$, 2.033 MeV $\frac{5}{2}^+$, and 2.429 MeV $\frac{3}{2}^+$ have an angular distribution with a preponderant L = 0 component. (J.S.R.)

3878 (CEA-CONF-1335) CLASSIFICATION OF THE NUCLEI OF ^{46}Ca BASED ON THE REACTIONS $^{39}K(^{3}He,d\gamma)^{46}Ca$ AND $^{46}Ca(p,p'\gamma)^{46}Ca$. Tellez, A.; Ballini, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 1p. (In French). CONF-690804-14). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

From a study of the $^{39}K(^{3}He,d\gamma)^{46}Ca$ and $^{46}Ca(p,p'\gamma)^{46}Ca$ reactions at incident energies of 18 and 12 MeV respectively it was possible to classify the majority of the levels of ^{46}Ca into four groups. The first group consists of levels of negative parity, strongly excited by $(^3He,d)$, and which are deexcited toward levels of the same group. In the second group are levels excited by (p,p') and not by ^{3}He and which are deexcited exclusively toward levels of the same group. The third consists of levels of negative parity, weakly excited by $(^3He,d)$, and which are deexcited partially toward levels of the second group. In the fourth group are levels excited by (p,p') and not by ^{3}He and which are deexcited principally toward levels of the first group. (J.S.R.)

3879 (IAE-1653) THE ELASTIC SCATTERING OF NEUTRONS WITH ENERGY 4 MeV IN SMALL ANGLES BY THE

NUCLEI OF COPPER, INDIUM, TIN, LEAD, BISMUTH, AND URANIUM. Gorlov, G. V.; Lebedeva, N. S.; Morozov, V. M. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1968. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Elastic scattering of polarized neutrons with $E_n = 4$ MeV at angles from 2 to 21° by Cu, In, Sn, Pb, Bi, and U nuclei was studied. It was found that the observed differential cross sections and polarization properties of the nuclei studied are well described, with the assumption of the existence of only nuclear or Coulomb (according to Schwinger) neutron scattering. Experimental values of differential and total cross sections were used for determining polarization properties of nuclei, differential cross sections of elastic scattering of unpolarized neutrons, and differential cross sections of nuclear forward elastic scattering. The magnitude of the polarization of neutrons in the D–D reaction at $E_d = 1.2$ MeV was measured. (tr-auth)

3880 (JINR–E6-4658) STUDIES IN THE DECAY OF 29-MIN ^{81}Sr. Broda, R.; Hrynkiewicz, A. Z.; Styczen, J.; Szawlowski, M.; Szeglowski, Z.; Walus, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 16p. Dep. CFSTI (U. S. Sales Only).

The gamma rays accompanying the decay of ^{81}Sr were studied with Ge(Li) spectrometer in single and coincidence configurations. About seventy transitions were identified with the decay of 29-min ^{81}Sr and their energies and relative intensities were determined. On the basis of the observed coincidences the decay scheme of ^{81}Sr is proposed. Excited states were placed in ^{81}Rb at: 153.4, 188.3, 206.4, 301.2, 443.5, 574.6, 812.0, 820.0, 851.0, 865.5, 909.3, 1129, 1343.5, 1382, 1511, 1553 keV. The levels fed by positron decay were experimentally determined. (auth)

3881 A RE-ASSESSMENT OF THE ISOMERIC CROSS-SECTION RATIO IN ^{75}Ge. Cox, A. J.; Francois, P. E. (Univ. of Aston, Birmingham, Eng.). J. Inorg. Nucl. Chem., 31: 2957-8(Sept. 1969).

Previous reported measurements of this ratio for 14-MeV neutrons were discordant, values of 0.40 ± 0.11 and 0.855 ± 0.074 being given. In the studies described As_2O_3 was irradiated with fast neutrons from the D-T reaction produced by a 150 keV S.A.M.E.S. accelerator to give ^{75m}Ge by the ^{75}As(n,p)^{75m}Ge reaction. The neutron energy was between 14.3 and 14.7 MeV. Measurements of the induced γ-ray activities were made with a NaI(Tl) scintillation spectrometer. The 136-keV isomeric transition γ-ray was measured after an irradiation of 2 min., and the 264-keV γ-ray arising in the ground state transition after a 30 min. irradiation. The measurements gave a value of 0.82 ± 0.08 for the ratio of the cross section for the production of the isomeric state to the total (n,p) cross section. Uncertainties are stated. (UK)

3882 SINGLE HOLE STATES IN MEDIUM-WEIGHT NUCLEI. Pittel, Stuart. Minneapolis, Univ. of Minnesota. 260p.

Thesis.

There has recently been a series of experiments to study the spectrum of hole states in ^{43}Ca through the pickup of a neutron from ^{44}Ca. The results of these experiments show that to describe these hole states properly, one must study the effect of configuration mixing on them. A calculation of this type was performed. The states were assumed to arise from a 4p – 1h configuration in which the four particles are restricted to the 1 $f_{\frac{7}{2}}$ shell and the single hole to the s-d shell. The energy matrices were calculated and then diagonalized for both the T = $\frac{3}{2}$ and T = $\frac{5}{2}$ states and for the various possible angular momenta. The general agreement with the experimental spectra was quite good although all the T = $\frac{5}{2}$ states were calculated to be systematically lower than was expected. The second phase of the analysis was to use the resulting eigenstates to study some of the more interesting properties of these levels. The first properties analyzed concerned the ^{44}Ca(p,d)^{43}Ca and ^{42}Ca(d,p)^{43}Ca reactions, which were used experimentally to excite these levels. Spectroscopic factors were calculated for these two reactions and the results were then compared with the experimental excitation spectra. It was seen that the calculated states could be incorporated into a picture consistent with the experimental results. An effort was then made to evaluate log ft values for the allowed Gamow-Teller decays of the ^{43}K. The resulting values of 6.4 and 5.4 respectively showed quite clearly the desired inhibition for these two decays. The final properties considered were the various electromagnetic transitions in which these states participate. Hindrance factors were calculated for the M2 decays of the 0.99 MeV $\frac{3}{2}^+$ level to the $\frac{7}{2}$ ground state and to the first excited $\frac{5}{2}^-$ state. Transition rates for the E2 and M1 decays taking place between the even parity states were also obtained. Good agreement was obtained in all cases except for the M2 decay to the $\frac{5}{2}^-$ state. However, the experimental determination of this lifetime was subject to many uncertainties, and may be in error. Since the even parity states in ^{51}Cr are very closely related to those in ^{43}Ca, an effort was made to analyze them as well. The energy spectrum of T = $\frac{3}{2}$ states was evaluated and it was seen that the lowest even parity state lies about 11 MeV above the ground state. This feature was explained qualitatively by comparing the various contributions to the ^{51}Cr interaction matrix with similar ones in ^{43}Ca. (Disser. Abstr.)

3883 (d,pγ) DIRECTIONAL CORRELATIONS OF ^{24}Mg(d,pγ)^{25}Mg. Davis, William Edward, Columbus, Ohio, Ohio State Univ., 1968. 235p.

Thesis.

The (d,pγ) directional correlations $W(\theta_\gamma,\varphi_\gamma)$ of the ^{24}Mg(d,pγ)^{25}Mg reaction proceeding through the 0, $\frac{5}{2}$, $\frac{1}{2}$ spin sequence were measured at proton angles (lab) of 45, 60, 80, and 123 and at the deuteron energy (lab) of 5 MeV. The gamma ray involved was the 1.38-MeV, E2 gamma ray from the transition between the 1.96-MeV, $\frac{5}{2}^+$ fourth excited state and the 0.58-MeV, $\frac{1}{2}^+$ first excited state of ^{25}Mg. Measurements were made at gamma ray angles both in and out of the reaction plane and at angles between 30 and 150° relative to the beam. DWBA stripping theory was used to obtain model dependent statistical tensors of the 1.96-MeV ^{25}Mg state from the parameters of fits to the correlation function measured in a single plane. The agreement of the tensors obtained from different planes is taken as confirming the applicability of the spin-orbit independent theory. Also, theoretical values for the tensors were calculated from reduced transition amplitudes determined from ORNL Code JULIE. These calculated tensors showed a strong dependence on the different sets of optical model parameters that were used; the sets differed chiefly in the real well depth. The addition of spin-orbit coupling to either or both of the entrance and exit channels made only small changes in the shapes of the angular distributions of the tensors. The measured and calculated tensor angular distributions have the same shape for some of the sets of optical model parameters but they do not have the same magnitude. The equations for determining the statistical tensors from the parameters of a fit to a single plane of the correlation function are developed in the coordinate system where the z-axis is along $\underline{k}_d$ and the y-axis is along $\underline{k}_p \times \underline{k}_d$. In this coordinate system there is a plane in which the highest order equation that need be solved is quadratic, in contrast to the usual cubic equation. Even if the quadratic equation has two real roots, and thus two sets of tensors are generated, only two of the eight tensors will have different values in the second set. (Disser. Abstr.)

3884 NEUTRON RESONANCES IN ^{34}S, ^{40}Ar, AND ^{48}Ca. Seibel, Frederick Truman Jr. Durham, N. C., Duke Univ., 1968. 89p.

Thesis.

The total neutron cross sections of ^{34}S, ^{40}Ar, and ^{48}Ca were measured with high resolution (1.5 keV) in the keV region (30 to 650 keV), using the ^{7}Li(p,n)^{7}Be reaction as a source of monoenergetic neutrons. The data were accumulated using an automatic acquisition system developed for use with an on-line computer. The observed resonances in the cross sections were fitted with an R-matrix multilevel formula. The average s-wave level spacings have been corrected to 6 MeV and combined with other spacing data for nuclei in this mass region. These spacings were compared to several models which include shell effects, in particular Newson and Duncan's model, Rosenzweig's model, and a variation of Newson and Duncan's model. The predictions of these models all qualitatively fit the data if one assumes that a magic number occurs at nucleon number 16 rather than at 20, which corresponds to a major shell closure near the ground state. This indicates that in compound nuclei at approximately 8 MeV excitation the $D^{\frac{5}{2}}$ subshell overlaps the $F^{\frac{7}{2}}$ shell. (Disser. Abstr.)

3885 THE DECAY OF 4.1 HOUR ^{71m}Zn AND THE LEVELS OF ^{71}Ga BY THE UNIFIED MODEL. Cooper, L. R.; Easterday, H. T. (Oregon State Univ., Corvallis). Nuovo Cim., 64B: 188-200(Nov. 11, 1969).

Precision spectroscopy experiments were carried out on gamma-radiations emitted in the decay of 4.1 h ^{71m}Zn, and several new transitions were identified. The presently accepted decay scheme was modified to include these transitions, and several ambiguities in the level structure were resolved. Using the intermediate-coupling unified model, the level energies of ^{71}Ga were calculated. Vibrational phonon states of the core nucleus ^{70}Zn are coupled to proton single-particle states, $2p_{\frac{3}{2}}$, $1f_{\frac{5}{2}}$, and $2p_{\frac{1}{2}}$. The coupling interaction is taken as either Gaussian or derivative Saxon-Woods shape; radial wave functions are either harmonic-oscillator functions or those generated by a Saxon-Woods potential. (auth)

3886 FRESNEL DIFFRACTION PATTERNS IN THE ^{26}Mg(^{3}He,α)^{25}Mg REACTION AT 5 MeV, ANALYZED BY THE

METHODS OF COMPLEX ANGULAR MOMENTA. Notarrigo, S. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy); Rubbino, A.; Sambataro, S.; Zubke, D. Nuovo Cim., 64B: 7-18(Nov. 11, 1969).

Differential cross sections for the $^{26}Mg(^3He,\alpha)^{25}Mg$ reaction were measured in the energy range 4 to 6 MeV of the incident beam, in steps of 50 keV, for five α groups leading to the lowest levels of the residual nucleus. By methods of complex angular momenta a diffraction formula was derived which fits nicely the experimental data. The diffraction formula was compared with the DWBA calculations by numerical experiments. (auth)

3887 RESONANCE STRENGTHS AND DECAY SCHEMES IN $^{23}Na(p,\gamma)^{24}Mg$. Baxter, A. M.; Cassell, K. J.; Kuehner, J. A. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 2319-26 (Nov. 1, 1969).

Six resonances in the reaction $^{23}Na(p,\gamma)^{24}Mg$ have been studied using a 40 cm^3 Ge(Li) detector. These resonances occur at proton energies of 512, 987, 1020, 1174, 1318, and 1416 keV. Decay schemes and branching ratios for the levels in ^{24}Mg corresponding to the resonances have been established and a number of discrepancies between this and previous work have been found. Resonance strengths and hence γ-decay widths for the resonances at 987, 1020, 1174, and 1318 keV have been obtained in terms of the known width of the 512 keV resonance. The observation of a weak transition from the 1416 keV resonance to the 9.46 MeV level in ^{24}Mg plus a Doppler-shift measurement on the decay of the 9.46 MeV level have permitted the spin and parity of the 9.46 MeV level to be restricted to 3^+ or 4^- with the former favored. (auth) (UK)

3888 DEFORMED STATE ADMIXTURES IN MASS-42 NUCLEI. Flowers, B. H.; Skouras, L. D. (Univ. of Manchester, Eng.). Nucl. Phys., A136: 353-84(1969).

An attempt is made to explain the energy spectrum and transition rates in ^{42}Ca and ^{42}Sc by considering admixtures of 4p–2h deformed and 2p spherical shell-model states for the low-lying levels. Two methods of handling the 4p–2h deformed states were considered; both treat the four-particle wave function in the same way but in the first method the two holes occupy a deformed orbit in a similar way to the four particles, while in the more extended second method the four-particle states are coupled to a complete set of two-hole states in the s-d shell. Using three variational parameters (the deformation parameters) and three fitted parameters (effective charge, $f_{\frac{7}{2}}-d_{\frac{5}{2}}$ energy splitting and the overlap between spherical and deformed ^{40}Ca cores), (in the case of the extended model) the positive-parity spectrum and the transition rates of ^{42}Ca up to 3.4 MeV excitation energy are reproduced to a good approximation. With this model the two 1^+ states recently observed at about 2 MeV excitation in the T = 0 spectrum of ^{42}Sc, and the large number of low-lying levels in the spectrum of this nucleus are also accounted for. The simpler model was used to investigate the nature of some pure deformed states in the low-lying spectrum of ^{42}Sc which have probably not yet been detected experimentally. (auth)

3889 STUDY OF CERTAIN EXCITED STATES OF THE NUCLEI $^{21}Ne(E_{ex} = 4.728$ MeV), $^{22}Ne(E_{ex} \leqq 5.633$ MeV), AND $^{23}Ne(E_{ex} = 3.22$ MeV). Chambon, B. (Institut d'Etudes Nucleaires, Algiers): Drain, D.; Yaker, M.; Dumazet, G.; Salmer, G.; Beaumevieille, H.; Lambert, M.; Nguyen Van Sen. Nucl. Phys., A136: 311-20(1969). (In French).

With a differentially pumped gas target for ^{20}Ne, and an isolating nickel foil for ^{21}Ne and ^{22}Ne, absolute differential cross sections for proton groups from the $^{20}Ne(d,p_{12})^{21}Ne$, $^{21}Ne(d,p_{1-8})^{22}Ne$ and $^{22}Ne(d,p_6)^{23}Ne$ reactions were measured at 3 MeV. The results indicate a direct reaction mechanism and good agreement is obtained with angular distributions from DWBA calculations. These comparisons allow a determination of parities and spectroscopic factors for the following states: ^{21}Ne, 4.73 MeV; ^{22}Ne, 1.277, 4.473, 5.139, 5.34, 5.520 and 5.633 MeV; and ^{23}Ne, 3.22 MeV. (auth)

3890 EFFECT OF THE SPIN–ORBIT FORCE IN THE SU_3 CLASSIFICATION SCHEME FOR ^{20}Ne. Harvey, M.; Sebe, T. (Chalk River Nuclear Labs., Can.). Nucl. Phys., A136: 459-64(1969).

The effect of a single-particle $(s \cdot l)$ force in ^{20}Ne is shown to admix only a few representations of SU_3 independently of the strength. The admixture strongly suggests a collective mode and a useful truncation of the shell-model configurations. (auth)

3891 (d,α) REACTIONS ON NUCLEI IN THE MASS RANGE 24 TO 41. Bottega, A.; McMurray, W. R.; Naude, W. J. (Southern Universities Nuclear Inst., Faure, South Africa). Nucl. Phys., A136: 265-85(1969).

The (d,α) reaction cross sections for ^{24}Mg, ^{25}Mg, ^{27}Al, ^{32}S, ^{35}Cl, ^{39}K and ^{41}K were measured as a function of deuteron energy and alpha angle over the range E_d = 4.0 to 5.5 MeV. The reaction mechanism was examined by analyzing the data in terms of Ericson fluctuation theory and Hauser–Feshbach theory. The observed cross sections show the behavior expected from Ericson theory. The shapes of the average angular distributions and the relative magnitudes of the differential cross sections agree with those predicted by Hauser–Feshbach theory for states of known spin. Probable spins were deduced for previously unassigned states of ^{23}Na, ^{30}P, ^{33}S and ^{37}Ar. The usefulness of the 2I + 1 rule is also examined. Average level widths Γ are derived from the fluctuation analysis and used in the normalization of Hauser–Feshbach calculations to obtain values of the average level spacing D_J in the compound nuclei excited at 15 to 21.5 MeV. These parameters are shown to have mass and excitation dependence consistent with Fermi-gas-model predictions in agreement with data obtained at lower nuclear excitation. An inhibition factor of 0.6 ± 0.2 was obtained for the isospin-forbidden transition to the 2^+ (T = 1) state at 2.94 MeV in ^{30}P which corresponds to a value of $\langle H_c \rangle \approx 24$ keV at an excitation of 16.5 MeV in ^{34}Cl. (auth)

3892 PROTON PICK-UP FROM THE 2s–1d AND 1p SHELLS OF ^{32}S. Kaschl, G. Th. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Mairle, G.; Schmidt-Rohr, U.; Wagner, G. J.; Turek, P. Nucl. Phys., A136: 286-300(1969).

Energy spectra and angular distributions of ^3He particles from the $^{32}S(d,^3He)^{31}P$ reaction were measured at an incident energy of 52 MeV. A total of 15 levels was observed up to an excitation energy of 10 MeV. A yet unknown $\frac{1}{2}^+$ level at $E_x = 6.41 \pm 0.06$ MeV was observed. The whole $1d_{\frac{3}{2}}$ strength is concentrated in one single state while the $2s_{\frac{1}{2}}$ and especially the $1d_{\frac{5}{2}}$ strengths are split into several levels. The spectroscopic factors of positive parity states agree fairly well with recent shell model calculations. As predicted by an effective interaction calculation, 1p hole states were observed at an energy much lower than expected from an (e,e'p) experiment. Angular shifts between measured and calculated angular distributions were found to be of the type of recently reported shell effects. The observed forward angle j-effect fits perfectly into this concept. (auth)

3893 RADIOCHEMICAL INVESTIGATION OF PRODUCTS FROM THE SPLITTING OF PRASEODYMIUM NUCLEI BY PROTONS WITH AN ENERGY OF 660 MeV. Lavrukhina, A. K.; Kuznetsova, R. I.; Kolesov, G. M.; Malyshev, V. V. Radiokhimiya, 11: 330-8(1969). (In Russian).

The radioactive products, in Z regions from 44 to 60 and from 95 to 141, from the splitting of praseodymium nuclei by 660-MeV protons were studied. Isotopes with half-lives from 13 min to 470 days were identified and the cross-sections for their formation determined. The distributions of the isotopes are not described by simple formulas. In the region A = 126 to 141, close to the nucleus of the target, an exponential relation is not present. (tr-auth)

3894 ANGULAR CORRELATIONS IN $^{23}Na(p,\gamma)^{24}Mg$. Baxter, A. M.; Mabey, C.; Gillespie, B. W. J.; Kuehner, J. A. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 2327-34(Nov. 1, 1969).

The decays of two resonances in $^{23}Na(p,\gamma)^{24}Mg$ were studied by γ-γ angular correlation methods. These resonances occur at proton energies of 1020 and 1318 keV and correspond respectively to levels in ^{24}Mg at 12.671 and 12.957 MeV. In the latter case, the analysis of the data leads to an assignment of J = 1 to the level at 12.957 MeV. The angular correlation measurements confirm a previous assignment of J = 2 to the 12.671 MeV level and the information on magnetic substrate populations obtained from the angular correlation analysis, together with a measurement of the angular distribution of the 12.671 to 8.86 MeV transition, yield an assignment of 2^- to the ^{24}Mg level at 8.86 MeV. (auth)

3895 A STUDY OF THE EXCITED STATES OF ^{28}Si BY MEANS OF THE $^{27}Al(p,\gamma)^{28}Si$ REACTION IN THE ENERGY RANGE E_p = 0.29 TO 1.01 MeV. Meyer, M. A.; Wolmarans, N. S. (Univ. of Potchefstroom, South Africa). Nucl. Phys., A136: 663-72(1969).

The γ-decay of 21 resonances of the $^{27}Al(p,\gamma)^{28}Si$ reaction was studied in the energy range E_p = 0.29 to 1.01 MeV by means of a Ge(Li) detector. The energies of 22 bound levels were determined to an accuracy of the order of 1 keV. The Q-value of this reaction was found to be 11585.6 ± 0.7 keV. Mean lifetimes of 15 bound levels were obtained from γ-ray Doppler-shift measurements. The resonance at E_p = 885 keV and the bound levels at E_x = 7.38 and 8.26 MeV have $J^\pi = 2^+$. (auth)

3896 THE DECAY OF 8.8 MIN ^{49}Ca TO LEVELS IN ^{49}Sc. Chilosi, G.; O'Kelley, G. Davis; Eichler, Eugene (Oak Ridge National Lab., Tenn.). Nucl. Phys., A136: 649-56(1969).

The decay of 8.8 min ^{43}Ca was reinvestigated using a 35 cm^3 Ge(Li) detector and a scintillation pair spectrometer. Gamma rays were observed with energies (and intensities) of 2229.0 (0.29), 2372.3 (0.45), 3084.4 (100), 4071.9 (8.0), and 4738.2 (0.30) keV. The large log ft values for decay to the 2229.0 and 2372.3 keV states suggest positive parity assignments and identification as $s_{\frac{1}{2}}$ and $d_{\frac{3}{2}}$ proton hole states. (auth)

3897 THE 1080 keV RESONANCE OF THE ^{15}N(p,$\alpha\gamma$) REACTION. Cloud, S. D.; Ophel, T. R. (Australian National Univ., Canberra). Nucl. Phys., A136: 592-8(1969).

The spins of levels in ^{16}O excited by the ^{15}N(p,α_{γ}) reaction for proton energies between 898 and 1640 keV were derived from measurements with a Ge(Li) detector. Angular correlations, extracted from the Doppler-broadened profiles measured at each resonance, confirm that the spins of the 898, 1210 and 1640 keV resonances are 2^-, 3^- and 1^+ respectively and enable an assignment of 1^- to the weak, broad resonance at approximately 1080 keV. (auth)

3898 A STUDY OF THE ^{35}Cl LEVELS BY MEANS OF THE ^{34}S(^{3}He,d)^{35}Cl REACTION. Graue, A. (Univ. of Bergen); Herland, L. H.; Lien, J. R.; Sandvik, G. E.; Cosman, E. R.; Moore, W. H. Contract AT(30-1)-2098. Nucl. Phys., A136: 577-91(1969).

The ^{34}S(^{3}He,d)^{35}Cl reaction was studied with high resolution at 11 MeV bombarding energy. A detailed level scheme for ^{35}Cl has been determined up to an excitation energy of 5.8 MeV revealing several previously unobserved states. The l_p values and absolute spectroscopic factors extracted from a DWBA analysis of the experimental deuteron angular distributions have provided information on the single proton character of the wave functions for the T = $^1/_2$ states as well as for the lowest T = $^3/_2$ isobaric analog of the ^{35}S ground state. A comparison between the present data and those of previous experiments is made and the results are discussed in terms of the existing shell-model and unified model calculations of this nucleus. Information on Coulomb displacement and symmetry energies is also extracted. (auth)

3899 DECAY OF ^{51}Cr. Hill, John C. (Texas A and M Univ., College Station). Nucl. Phys., A136: 564-6(1969).

The decay of ^{51}Cr to levels of ^{51}V was investigated using a Ge(Li) detector. The only γ-ray observed was the well-known one at 320 keV. No evidence was found for other γ-rays reported in earlier work. Upper limits on the intensity of these γ-rays were established through singles and coincidence measurements. (auth)

3900 THRESHOLD EFFECTS IN THE ^{40}Ar(d,p)^{41}Ar REACTION. Cosack, M.; Leung, M. K.; McEllistrem, M. T.; Schulte, R. L.; Stautberg, M. M.; Weil, J. L.; Norman, J. C. (Univ. of Kentucky, Lexington). Nucl. Phys., A136: 532-44(1969).

An anomaly attributed to isospin coupling was observed in the excitation functions of the ^{40}Ar(d,p)^{41}Ar reaction to the fourth excited level of ^{41}Ar. The anomaly was observed near the threshold of the ^{40}Ar(d,n)^{41}K reaction to the analog of the ^{41}Ar level. The position of the (d,n) threshold was measured by observing protons ($\bar{p}$) from the subsequent decay of ^{41}K. A narrow anomaly is also observed in the excitation functions of the p_0 and p_2 groups at about the expected threshold energy of the (d,n_3) reaction to the ground state analog, which may be evidence for coupling of other than just analog channels. (auth)

3901 STUDY OF THE ^{22}Ne(α,n)^{25}Mg REACTION: A POSSIBLE SOURCE OF STELLAR NEUTRONS. Ashery, D. (California Inst. of Tech., Pasadena). Nucl. Phys., A136: 481-95 (1969).

The ^{22}Ne(α,n)^{25}Mg reaction was studied at bombarding energies 1.9 to 4.7 MeV, using pulsed beam time-of-flight spectroscopy. Angular distributions of the neutrons were taken at energy intervals of 60 to 100 keV. Simultaneously the gamma yield from the excited states in ^{25}Mg was detected. The cross sections for the various final states in ^{25}Mg, as well as the total cross section for the reaction, were obtained. The reaction is shown to proceed mainly through resonances in the compound system. Twelve resonances are identified, of which seven are also assigned spins and parities. The reaction is shown to be a possible major neutron source for the s-process in massive stars. (auth)

3902 INELASTIC SCATTERING OF 61 MeV PROTONS FROM ^{89}Y AND THE ASSOCIATED REACTION MECHANISMS. Scott, A. (Univ. of Georgia, Athens); Whiten, M. L.; Love, W. G. Nucl. Phys., A137: 445-66(1969).

The differential cross sections for the excitation of the first seven resolved excited states of ^{89}Y by 61.2 MeV protons were measured over the angular range 17 to 120°. One of these is the weakly excited state at 2.62 MeV. The inelastic scattering data are analysed using the collective model and a microscopic model including both core polarization and a central spin-dependent effective interaction. (auth)

3903 NEGATON SPECTRUM OF ^{76}As. Nagarajan, T.; Ravindranath, M.; Reddy, K. Venkata (Andhra Univ., Waltair, India). Nucl. Phys., A137: 467-73(1969).

A FK analysis with proper shapes for the outer beta groups yielded beta groups with endpoints 2970 ± 2 (50%), 2410 ± 4 (31%), 1785 ± 7 (7%), 1184 ± 20 (3%) and 320 ± 30 (1.8%) keV, which fit very well in the level scheme of ^{76}Se. A large $\int B_{ij}$ contribution is expected for the 2.41 MeV beta group because its log ft value is comparable to that of the outer unique group and also the condition $\xi \gg W_0$ is not well fulfilled. No precise data are available on its shape, and the contribution of the 1852 keV beta group is ignored in a previous work. The present measurement (a = −0.007 ± 0.01) yields a surprisingly statistical character for this transition which therefore cannot be analyzed under the "modified B_{ij} approximation." However an earlier analysis by Fischbeck and Newsome under the latter formalism indicated two possibilities for the configuration of the 2^+ first excited level of ^{76}Se for which the shapes were nearly statistical. A further distinction between these two possibilities will require an analysis employing exact formulas and data on angular and energy dependence of circular polarization. Incidentally, it was found that the outer first-forbidden unique transition requires an additional small-order shape factor (a = −0.027 ± 0.008) for its complete description. (auth)

3904 ANGULAR CORRELATION ANALYSIS OF THE ^{58}Ni(p,p'γ) REACTION. Van Patter, D. M. (Bartol Research Foundation, Swarthmore, Pa.); Horoshko, R. N.; Scott, Hugh L.; Hinrichsen, P. F. Nucl. Phys., A137: 353-88(1969).

Energy averaged angular distributions were measured for ^{58}Ni(p,p'γ) radiations at E_p = 6.52 and 6.92 MeV for states up to 4.1 MeV excitation, using a Ge(Li)-NaI(Tl) coincidence-anti-coincidence spectrometer. In order to obtain spin assignments and γ-ray multipolarities, the data were analyzed in terms of χ^2 fits to predictions of statistical reaction theory. The present results, together with other recent measurements, lead to best energies and J^π values for ^{58}Ni levels: namely 1454.0 ± 0.1 keV 2_1^+, 2459.1 ± 0.3 4_1^+, 2775.2 ± 0.2 2_2^+, 2901.8 ± 0.2 1_1^+, 2942.4 ± 0.0 2_3^+, 3037.6 ± 0.3 2_4^+, 3263.4 ± 0.2 2_5^+, 3420.3 ± 0.3 $3_1^{(+)}$, 3530.9 ± 0.3, 3593.4 ± 0.3 $1_2^{(+)}$, 3620.0 ± 0.0 4_2^+, 3774.4 ± 0.4 $3_2^{(+)}$, 3898.3 ± 0.3 2_6^+, and 4107.7 ± 0.3 $2_7^{(+)}$. The previously accepted 4^+ assignment for the 3530.9 keV level was ruled out. Available information concerning the γ-ray branches, multipolarities and transition rates is discussed. Outstanding discrepancies with shell-model predictions for energy spectra and transition rates are pointed out, particularly with regard to the energies of the 1_1 and 1_2 levels and the puzzling γ-ray decay properties of the 0_2^+ state. (auth)

3905 g-FACTOR OF THE 810.5 keV LEVEL IN ^{58}Fe. Singh, Vikram; Tandon, P. N.; Devare, S. H.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A137: 278-80(1969).

The g-factor of the first excited 2^+ state at 810.5 keV in ^{58}Fe is measured to be g = +0.54 ± 0.17 from the measured rotation of the 863.6 to 810.5 keV gamma cascade using the perturbed angular correlation technique. The large hyperfine field present in iron is used. The measured value is consistent with the vibrational character of this state. In addition the mixing parameter δ for the 863.6 keV gamma is determined to be δ = +1.46 ± 0.07 from the analysis of the angular correlation of this cascade. (auth)

3906 LIFETIME MEASUREMENTS OF EXCITED NUCLEAR STATES IN ^{72}Ga. Kugler, H. (Technische Univ., Brunswick). Nucl. Phys., A137: 281-8(1969).

By delayed coincidence techniques, the following half-lives of excited nuclear levels in ^{72}Ga, populated by the decay of ^{72}Zn, were measured: 16.4 keV, $T_{\frac{1}{2}}$ = 39.2 ± 0.7 ns; 119.2 keV, $T_{\frac{1}{2}}$ = 34.5 ± 5.6 ms; 161.1 keV, $T_{\frac{1}{2}}$ = 0.59 ± 0.03 ns; 207.9 keV, $T_{\frac{1}{2}} \leq$ 0.19 ns. These values are compared with the theoretical predictions of the quasiparticle model of Kisslinger and Sorensen to determine the parity of the first and second excited state in ^{72}Ga: 16.4 keV (2^-), and 119.2 keV (0^+). (auth)

3907 NUCLEAR LIFETIMES FROM BOMBARDMENT OF $^{2\ 3}$H BY $^{20\ 22}$Ne. Bharuth-Ram, K.; Jackson, K. P.; Jones, K. W.; Warburton, E. K. (Oxford Univ.). Nucl. Phys., A137: 262-72 (1969).

Deuterium and tritium targets were bombarded with ^{20}Ne and ^{22}Ne beams with energies near 30 MeV. Gamma rays resulting from the induced reactions were observed with Ge(Li) detectors

and nuclear lifetimes were extracted by the Doppler-shift attenuation method. Lifetimes for the indicated nuclei and excitation energies are as follows: ^{21}Ne (2797 keV, <50 fs; 4526 keV <50 fs; 4693 keV, <50 fs; 4726 keV, <50 fs), ^{21}Na (2432 keV, <50 fs), ^{19}F (4648 keV, 2.3 ± 0.5 ps), ^{24}Ne (1981 keV, $1.0^{+0.2}_{-0.4}$ ps; 3867 keV, <100 fs). (auth)

3908 ROLE OF TENSOR FORCE IN CHARGE EXCHANGE REACTIONS. Rost, E.; Kunz, P. D. (Univ. of Colorado, Boulder). Phys. Lett., 30B: 231-2(Oct. 13, 1969).

The discrepancy between theory and experiment in the analysis of the ^{54}Fe(^{3}He,t)^{54}Co reaction is removed by including tensor force in the effective interaction. (auth)

3909 ELASTIC SCATTERING OF 27.2 MeV α PARTICLES ON MEDIUM-WEIGHT NUCLEI. Alekseev, V. V.; Gonchar, V. G.; Dobrikov, V. N.; Polyanskii, V. N.; Terenetskii, K. O.; Tokarevskii, V. V.; Shcherbin, V. N. (Inst. of Physics, Kiev. Kiev State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1726-32(1968). (In Russian).

Elastic scattering of 27.2-MeV α particles on ^{50}Cr, ^{56}Fe, ^{59}Co, ^{58,60}Ni, ^{63,65}Cu, ^{64,66,67,70}Zn was studied. Comparisons of theoretical and experimental data showed that the optical model effectively described the angular distribution of elastically scattered α particles over all angles for ^{56}Fe, ^{59}Co, ^{58,60}Ni, and ^{70}Zn and at angles smaller than 120° for ^{50}Cr, ^{63,65}Cu, and ^{64,66,67}Zn. (R.V.J.)

3910 REACTION LIST FOR CHARGED-PARTICLE-INDUCED NUCLEAR REACTIONS. PART B: Z = 28 TO Z = 99 (Ni TO Es). McGowan, F. K.; Milner, W. T.; Kim, H. J.; Hyatt, Wanda (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. A, 7: No. 1-2, 1-232(Nov. 1969).

This reaction list for charged-particle-induced nuclear reactions was prepared from the journal literature for the period from 1948 through April 1969. Each published experimental paper is listed under the target nucleus in the nuclear reaction with a brief statement of the type of data in the paper. The nuclear reaction is denoted by A(a,b)B, where $M_a \geq$ (one-nucleon mass). There is no restriction on energy. Nuclear reactions involving mesons in the outgoing channel are not included. (auth)

3911 ENERGY OF THE 834 keV GAMMA LINE IN ^{72}Ga DECAY. Larsson, C.; Broman, L. (Chalmers Univ. of Tech., Goteborg). J. Inorg. Nucl. Chem., 31: 3692-3(Nov. 1969).

The energy of the most dominant gamma line in ^{72}Ga decay was redetermined using a Ge(Li) detector and found to be 834.12 ± 0.08 keV. The experimental procedure is described in detail. The energies and relative intensities of some previously unreported ^{72}Ga decay gamma lines are also given. (UK)

3912 BETA DECAY OF ^{42}Ti. Aldridge, A. M.; Kemper, K. W.; Plendl, H. S. (Florida State Univ., Tallahassee). Phys. Lett., 30B: 165-6(Sept. 29, 1969).

The ground-state β^+ decay of ^{42}Ti was investigated through the reaction ^{40}Ca(^{3}He,n). The half-life was found to be 173 ± 14 ms. The branching ratios to the 1^+ level at 615 keV and to the 0^+ ground state in ^{42}Sc are 56 ± 14% and 44 ± 14%, respectively. The calculated log ft values are 3.11 ± 0.14 for the $0^+ \rightarrow 1^+$ transition and 3.43 ± 0.12 for the $0^+ \rightarrow 0^+$ transition. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 3492, 3503, 3720, 3836, 3858, 3876, 3879, 3910, 3953, 3955, 3956, 3978, and 3980.

3913 (AERE-M-2230) THE STRUCTURE OF DATA FILES 78 AND 79, FOR NIOBIUM, AND FILE 81 FOR MOLYBDENUM, IN THE U.K.A.E.A. NUCLEAR DATA LIBRARY. Blow, S.; Lipscombe, B. A. (Atomic Energy Research Establishment, Harwell (England)). June 1969. 11p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

The sources of information, and the nuclear reactions which were considered, in setting up nuclear data files for the following nuclides: Nb at 900°K (file 78); Nb at 300°K (file 79); and Mo at 300°K (file 81), are listed. A comprehensive source of information on the nuclear data library is the AWRE Report 0-70/63. (auth) (UK)

3914 (AERE-R-6154) YIELDS FROM THE THERMAL NEUTRON INDUCED FISSION OF ^{241}Pu. Croall, I. F.; Willis, H. H. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1969. 4p. Dep. CFSTI (U. S. Sales Only). UK 1s. 9d.

The cumulative yields of 13 nuclides from the thermal neutron induced fission of ^{241}Pu were determined. The independent yield of ^{96}Nb was also measured. Other measurements of ^{241}Pu fission yields are tabulated for comparison. (auth)

3915 (ANL-7512) PHYSICS DIVISION SUMMARY REPORT, APRIL-DECEMBER 1968. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 165p. Dep. CFSTI.

Short summaries are presented of research projects completed or in progress during April through December, 1968 at the Physics Division of Argonne National Laboratory. (J.W.R.)

3916 (ANL-7570) PHYSICS DIVISION SUMMARY REPORT, JANUARY-MARCH 1969. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 59p. Dep. CFSTI.

Short summaries are presented of research projects completed or in progress during the period January through March, 1969 at the Physics Division of Argonne National Laboratory. (J.W.R.)

3917 (CEA-CONF-1324) IDENTIFICATION OF ROTATION BANDS THROUGH QUANTITATIVE ANALYSIS OF ANALOGUE RESONANCES. Cassagnou, Y.; Foissel, P.; Levi, C.; Mittig, W.; Papineau, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 1p. (In French). (CONF-690804-6). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

The analog states of deformed nuclei were studied by elastic and inelastic resonant scattering of protons on ^{170}Yb, ^{171}Yb, ^{172}Yb, ^{174}Yb, ^{176}Yb, ^{154}Gd, and ^{158}Gd. A complete calculation of cross sections in the absence of all non-resonance contribution was made. The results obtained for the analog states of ^{173}Yb observed by inelastic scattering toward the 4^+ level were presented. The spin $3/2^-$ ($3/2^-$[501]) was attributed to the 665-keV level and the $1/2^-$ ($1/2^-$[503]) level was placed at 1714 keV. Similar identifications were made for the other nuclei. (J.S.R.)

3918 (CEA-CONF-1325) SPECTROSCOPY OF THE NUCLEUS N = 82 WITH THE AID OF THE REACTIONS (p,d) AND (p,t) AT 24.55 MeV. Bruge, G.; Chaumeaux, A.; Long, Ha Duc; Picard, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 1p. (In French). (CONF-690804-5). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

The 1- and 2-hole neutron states were studied in ^{138}Ba, ^{140}Ce, ^{142}Nd, and ^{144}Sm. The angular distributions relative to the excited state of the residual nucleus were compared for the 1-hole states with the DWBA predictions. Transferred angular moments 1, 0, 2, 4, and 5 were obtained corresponding to the orbits $3s_{1/2}$, $2d_{3/2}$ or $2d_{5/2}$, $1g_{7/2}$, and $1h_{11/2}$. The results are tabulated. The angular distributions of the tritons are under analysis. (J.S.R.)

3919 (CEA-CONF-1330) CONDITION OF PROTON PARTICLE HOLES IN THE TIN ISOTOPES 120 AND 122. Conjeaud, M.; Fernandez, B.; Harar, S.; Thuriere, E. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Chatterjee, M. L.; Cindro, N.; Turk, M. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)). [1969]. 1p. (In French). (CONF-690804-8). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

A typical spectrum, obtained at 35°, from the ^{121,123}Sb(t,α)^{120,122}Sn reaction is presented. The half-height of the peaks is about 35 keV. With the exception of the ground state and the levels at 1.14 MeV (2^+) and at 2.14 MeV (4^+), the transitions toward the first excited levels are not very intense. Between 1.2 and 3.7 MeV none of the states excited by inelastic scattering of the proton were observed. In this excitation region the states with positive parity do not have appreciable 1p-1t component. Above 3.76 MeV some levels appear strongly excited, and probably correspond to states of the 1p-1t type. Similar results were observed in the ^{121}Sb(t,α)^{120}Sn. (J.S.R.)

3920 (CEA-CONF-1329) REACTIONS $^{106,114}_{48}$Cd(^{3}He, d)$^{107,115}_{49}$In. Conjeaud, M.; Harar, S.; Thuriere, E. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 1p. (CONF-690804-7). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

Studies are under way to determine the properties of the first excited states of ^{115}In. Beginning at 800 keV excitation energy numerous levels appear which are not excited by the Sn(d,^{3}He)

reaction. The peopling of these states can be made by the transfer of a proton into the empty orbits. It does not seem necessary, as has been suggested previously, to introduce a rotational model to explain the location of these states at low excitation energy. In the reactions ^{115}In(^{3}He,d) the orbits $1g_{\frac{7}{2}}$, $2d_{\frac{5}{2}}$, ... appear toward 3.7 MeV above the ground ^{115}In by considering a pairing energy of about 2.8 MeV. By assuming that the spin and parity previously assigned are confirmed, the $^1/_2{}^+$ level at 935 keV is very excited by the ^{114}Cd(^{3}He,d) reaction with respect to the $^1/_2{}^+$ and $^3/_2{}^+$ levels unseparated at 828 and 864 keV and with respect to the $^3/_2{}^+$ at 1078 keV which is not excited. A detailed DWBA analysis is underway both for ^{106}Cd and ^{114}Cd. (J.S.R.)

3921 (CEA-CONF-1331) REACTION $^{130}_{52}$Te(t,α)$^{129}_{51}$Sb. Conjeaud, M.; Fernandez, B.; Harar, S.; Thuriere, E. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Chatterjee, M. L.; Kostalac, B.; Turk, M. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)). [1969]. 1p. (CONF-690804-9). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

A typical α spectrum measured at 50° from the ^{130}Te(t,α)^{129}Sb reaction is presented. The structure of this spectrum shows that the first excited stated from 0.064 to 0.91 MeV can be explained by the presence of two protons at the exterior of the core Z = 50 in the orbits $1g_{\frac{7}{2}}$, $2d_{\frac{5}{2}}$, $3s_{\frac{1}{2}}$. Above 2.7 MeV six peaks occur. They probably correspond to the capture of a proton in the orbits $1g_{\frac{9}{2}}$, $2p_{\frac{1}{2}}$, $2p_{\frac{3}{2}}$, $1f_{\frac{7}{2}}$. (J.S.R.)

3922 (COO-1505-39) RECOIL RANGES, EXCITATION FUNCTIONS, AND ISOMER RATIOS FOR THE ^{136}Ba(^{4}He,3n) AND ^{137}Ba(^{3}He,3n) REACTIONS. Porile, N. T.; Montgomery, D. M. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Oct. 20, 1969. Contract AT(11-1)-1505. 27p. Dep. CFSTI.

Average projected ranges and cross sections for the production of ^{137m}Ce and ^{137g}Ce from the ^{136}Ba(^{4}He,3n) and ^{137}Ba(^{3}He,3n) reactions were measured over the energy intervals 27 to 44 MeV and 14 to 33 MeV, respectively. The average ranges were found to be consistent with a compound nuclear process over the entire energy interval for both reactions. The isomer ratios were compared with a calculation based on the spin-dependent statistical theory and good agreement was obtained for reasonable values of the parameters of interest. Comparison is made with previous measurements and various discrepancies are discussed. (auth)

3923 (COO-1505-40) TEST OF THE INDEPENDENCE HYPOTHESIS BY ANGULAR DISTRIBUTION MEASUREMENTS. Porile, N. T.; Montgomery, D. M. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Oct. 20, 1969. Contract AT(11-1)-1505. 19p. Dep. CFSTI.

Angular distribution measurements of ^{137m}Ce and ^{137g}Ce from the reactions ^{136}Ba(^{4}He,3n) and ^{137}Ba(^{3}He,3n) were made over the energy range from 33.3 to 43.6 MeV and from 20.3 to 32.5 MeV, respectively. The results were analyzed to give the average total kinetic energy of the neutrons and photons emitted in the reactions. Comparison of these quantities at the same excitation energy and angular momentum of the compound nuclei shows that they are equal within the limits of error and thereby confirms the independence hypothesis. The observed differences in the average photon energies for reactions leading to ^{137m}Ce and ^{137g}Ce are quantitatively related to the difference in the average angular momentum of compound nuclei leading to each isomer. (auth)

3924 (ORNL-TM-2598) MEASUREMENTS OF THE NEUTRON FISSION AND ABSORPTION CROSS SECTIONS OF ^{239}Pu OVER THE ENERGY REGION 0.02 eV TO 30 keV. Gwin, R.; Weston, L. W.; de Saussure, G.; Ingle, R. W.; Todd, J. H.; Gillespie, F. E. (Oak Ridge National Lab., Tenn.); Hockenbury, R. W.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Oct. 7, 1969. 32p. Dep. CFSTI.

The neutron absorption and fission cross sections for ^{239}Pu were measured simultaneously over the neutron energy range from 0.02 eV to 30 keV. An electron linear accelerator was used to produce a source of pulsed neutrons which are collimated to impinge on the ^{239}Pu sample located at the center of a large liquid scintillator. The prompt gamma rays resulting from fission or from neutron capture were detected using the large liquid scintillator. A fission event was measured in one case by using an ionization chamber containing ^{239}Pu. In another case using metal foils of ^{239}Pu, a technique depending upon the difference in the shape of the pulse height distributions for the prompt gamma rays from fission and capture was used to distinguish fission events. The data were normalized at 0.025 and 0.3 eV using data previously reported. A brief description of the experiments is given and a comparison of the present data with previously published data is given. (auth)

3925 RANGES OF SHIELDED NUCLIDES FROM THERMAL-NEUTRON FISSION. Nakahara, H.; Harvey, J. W.; Gordon, G. E. (Massachusetts Inst. of Tech., Cambridge). Can. J. Phys., 47: 2371-85(Nov. 1, 1969).

Average ranges in Al of shielded nuclides ^{86}Rb and ^{136}Cs and several chain-yield species from thermal-neutron fission of ^{233}U and ^{235}U have been measured. The values obtained (in mg/cm^2 Al) are, for ^{233}U: ^{86}Rb, 3.88 ± 0.04; ^{136}Cs, 2.80 ± 0.01; and for ^{235}U: ^{86}Rb, 3.76 ± 0.03; ^{136}Cs, 2.81 ± 0.01. A range-energy transformation was used to determine average kinetic energies ($\bar{E}_r$) of the secondary fragments. In agreement with previous work, the shielded nuclides are found to have smaller $\bar{E}_r$ values than neighboring chain-yield species. The deficits of $\bar{E}_r$ are, for ^{233}U, 4 and 8 MeV, and for ^{235}U, 8 and 10 MeV, respectively, for ^{86}Rb and ^{136}Cs. Most of the range experiments were done with the thick-catcher method followed by conventional radiochemical treatment of the catcher foils. Ranges of 20 products from ^{233}U were determined in preliminary experiments in which gross γ-ray spectra of fission products in the catcher foils were observed with a Ge(Li) detector. The kinetic-energy deficits of the shielded species are interpreted by Monte Carlo calculations of prompt-neutron emission. (auth) (UK)

3926 MEASUREMENT OF TIME-DEPENDENT ENERGY SPECTRA OF ELECTRONS FROM ^{235}U FISSION FRAGMENTS FOR ELECTRON ENERGIES BELOW 1 MeV. Tsoulfanidis, Nicholas. Urbana, Ill., Univ. of Illinois, 1968. 122p.

Thesis.

The purpose of the present work was the absolute determination of the time dependent energy spectrum of electrons from fission fragments produced by the thermal fission of ^{235}U. Specifically, the measurements covered the electron energy range below 1 MeV. A fission source consisting of two ^{235}U deposits on a thin aluminum disk provided a localized source of fission fragments for electron production and also fission fragments for the fission rate determination. Electrons were detected by a plastic scintillator and fission fragments by a semiconductor surface barrier detector. The plastic scintillator, the fission fragment detector and the fission source were properly positioned in a vacuum chamber so that the geometry was known and reproducible. A thermal neutron beam from the TRIGA Reactor caused fissions in the ^{235}U deposit. Electron energy spectra were measured for the cases of: (i) spectrum build-up under constant fission rate; (ii) spectrum decay after 8 hours of constant fission rate; (iii) spectrum decay following a sudden burst of fissions induced by a reactor pulse. The measured electron spectra were corrected for the effects of energy resolution and source thickness. The corrections were applied by unfolding the measured spectra with the use of a proper system response function. The results are reported as electrons per MeV per sec per fission per sec, for the first two cases mentioned above and as electrons per MeV per sec per fission, for the case of the reactor pulse. The total number of electrons and the total beta energy per fission were also calculated for various times during the buildup or the decay of the spectrum. The results are compared with previous experiments and also with results of calculations. (Disser. Abstr.)

3927 IDENTIFICATION OF NEW NEUTRON-DEFICIENT NUCLIDES ^{76}Rb AND ^{118}Cs. HALF-LIVES OF ^{76}Rb, ^{119} ^{124}Cs, ^{126}Cs. Chaumont, J.; Roeckl, E.; Nir-El, Y.; Thibault-Philippe, C.; Klapisch, R.; Bernas, R. (CNRS, Orsay, France). Phys. Lett., 29B: 652-4(Aug. 18, 1969).

Using the on-line mass spectrometer technique neutron-deficient Rb and Cs nuclides produced by the bombardment of heavy elements with 24 GeV protons were investigated. (auth)

3928 THE MULTIPOLE MIXING RATIO OF $2'^+ \rightarrow 2^+$ TRANSITIONS IN ^{194}Pt AND ^{196}Pt. Hamilton, W. D. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys., A136: 257-64(1969).

Gamma-gamma and gamma-linear polarized gamma angular correlation measurements were used to determine the E2 : M1 multipole mixing ratio of $2'^+ \rightarrow 2^+$ transitions in ^{194}Pt and ^{196}Pt. The γ-γ measurements were made with a good resolution detector and the transitions were unambiguously identified. A summing polarimeter with a correlation angle of 90° was used for the linear polarization measurements. The magnitude and sign of δ for ^{194}Pt is in agreement with Kumar's theoretical value, while the result for ^{196}Pt disagrees markedly. (auth)

3929 THE DECAY OF 3.1 min ^{190}Re. Haustein, P. E.; Voigt, A. F. (Iowa State Univ., Ames). Nucl. Phys., A136: 414-22(1969).

The decay of the ground state of ^{190}Re(3.1 min) was investigated using Ge(Li) and scintillation detectors. Seventeen gamma-ray transitions following the ≈100% beta-decay branch to the 1387 keV

level of ^{190}Os were observed and placed into a decay scheme based on the known levels of ^{190}Os. A previously unreported 432 keV transition depopulating the 1387 keV level was observed. Beta-ray measurements yielded an end-point energy of 1.8 ± 0.2 MeV for ^{190}Re. Log ft calculations indicate that ^{190}Re has a spin between 2 and 4 and negative parity. Experiments on the electron capture decay of ^{190}Ir(12 d) into ^{190}Os levels confirmed these results. The previously reported 2.8 h ^{190}Re isomer was not observed. (auth)

3930 EXCITED STATES AND TRANSITIONS IN ^{199}Au. Okano, K.; Kawase, Y.; Uehara, S.; Hayashi, T. (Kyoto Univ.). Nucl. Phys., A136: 321-36(1969).

Gamma radiations and conversion electrons in the decay of 31 min ^{199}Pt to ^{199}Au were investigated by using Ge(Li) detectors and a Si-Ge(Li) conversion coefficient spectrometer. Thirty-nine gamma-ray lines were observed, including ten unreported lines. New levels were confirmed at 822.3 ± 0.05, 1069.6 ± 0.5, 1103.2 ± 0.3, 1158.7 ± 0.5, 1249.0 ± 0.4 and 1395.6 ± 0.5 keV on the basis of NaI(Tl)-Ge(Li) coincidence measurements. The spin and parity of the 791.4-keV level were determined as $3/2^+$ from the M1 character of the 714.1 keV transition. Angular correlations of four gamma-ray cascades of 191.7-542.7, 468.0-246.5, 474.5-317.0 and 714.1-77.1 keV were measured. The results are consistent with the spin assignments of $1/2$ and $3/2$ to the 77.1 and 323.6 keV levels respectively, the $1/2$ assignment to the latter level being excluded. From the measured conversion coefficients and angular correlation coefficients, the following M1-E2 mixing ratios were determined: 317.0 keV, M1 + (25 ± 10)% E2; 468.0 keV, M1 + <37% E2; 474.5 keV, M1 + (1.4 ± 0.4)% E2; 542.7 keV, M1 + $(0.3^{+0.6}_{-0.3})$% E2; 714.1 keV, M1 + <52% E2. The energy level spectrum obtained is compared with the theoretically calculated one based on the intermediate coupling model. The transition probabilities of the lower excited states are compared with theoretical predictions based on three different models. (auth)

3931 K-SHELL PARTICLE PARAMETER OF THE 122-keV TRANSITION IN ^{152}Sm. Blumberg, H.; Fechner, J.; Hammesfahr, A.; Herzog, P.; Kluge, A.; Voss, J. (Univ., Bonn). Z. Phys., 228: 391-5(1969).

The K-shell particle parameter of the 122 keV transition in ^{152}Sm was investigated using different sources and different experimental arrangements. From the measurements the mean value b_k = 1.77 ± 0.03 was obtained. This result deviates from the theoretical value by (6.5 ± 1.5)%. Hygroscopic effects as reported earlier were not observed. (auth)

3932 DETERMINATION OF THE RESONANCE ACTIVATION INTEGRALS OF ^{98}Mo, ^{103}Rh, AND ^{191}Ir AS WELL AS THE RESONANCE SELF-SHIELDING FACTORS FOR WIRES. Koehler, W.; Schneider, E. (Technische Hochschule, Munich). Nukleonik, 12: 197-204(Aug. 1969). (In German).

The resonance activation integrals of ^{98}Mo, ^{103}Rh, and ^{191}Ir and the self-shielding corrections for small pieces of wires were measured. The 1/v contribution subtracted, the values obtained are as follows: ^{98}Mo: I' = (6.38 ± 0.15) barn, ^{103}Rh: I' = (78 ± 7) barn for the isomeric state ($T_{1/2}$ = 4.41 ± 0.04 min), and I' = (1,054 ± 74) barn for the ground state ($T_{1/2}$ = 41.5 ± 0.5 min), ^{191}Ir: I' = (940 ± 160) barn for the isomeric state ($T_{1/2}$ = 1.4 m) and I' = (4,074 ± 285) barn for the ground state ($T_{1/2}$ = 74.2 d). The self-shielding correction factors of 0.15 mm thick wires were determined as Au : G_{epi} = 0.24; Rh : G_{epi} = 0.43; Ir : G_{epi} = 0.44. The G_{epi}-values of gold agree very well with the calculated ones. (auth)

3933 STUDY OF THE RESONANCE INTERACTION EFFECT BETWEEN ^{238}U AND ^{239}Pu IN THE LOWER ENERGY REGION. Haeggblom, H. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nukleonik, 12: 189-97(Aug. 1969).

An investigation was made of the statistical frequency function for the distances between the ^{238}U and the ^{239}Pu resonances in the region 4 to 244 eV. It is concluded that the frequency function is probably constant but that the distances diverge appreciably from a constant function in the actual case, and that the divergence is such that the interaction effect on the resonance integral is smaller than would be expected from statistical considerations. This is also confirmed by calculations on the interaction effect. These were performed using three different methods, namely: (a) considering the actual positions and widths of the resonances; (b) assuming a constant frequency function for the resonance spacing and applying a theory developed by Rowlands and Fischer; (c) applying a simplified, approximate method for calculations based on the statistical theory. The calculations are made for two temperatures and two values of the plutonium enrichment. It is shown that the average cross sections are considerably larger than the statistical calculations indicate. (auth)

3934 DECAY OF ^{162}Yb. Paris, Pierre (Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, France). Compt. Rend., Ser. B, 268: 1534-6(June 9, 1969). (In French).

The decay of ^{162}Yb to the excited levels of ^{162}Tm is investigated. The first results of this study, accomplished with the help of semiconductor detectors, are presented and a diagram of partial levels is proposed. (tr-auth)

3935 MEASUREMENT OF NEUTRON-INDUCED, FISSION-FRAGMENT ENERGY SPECTRA IN THE ADVANCED LABORATORY. French, W. R. Jr.; Bunting, R. L. (Nebraska Wesleyan Univ., Lincoln). Amer. J. Phys., 37: 637-45(June 1969).

Fission experiments can be profitably performed in the Advanced Laboratory. Measurement of the fragment energy spectrum from a fissile source using a surface barrier detector demonstrates several characteristics of the fission process. Experimental difficulties in such measurements are discussed, and typical results are presented for neutron-induced fission with sources of natural uranium and those enriched in ^{235}U. Also shown are the results with the spontaneous fissile source ^{252}Cf. (auth)

3936 THE B(E2) RATIO OF TRANSITIONS TO THE FIRST EXCITED STATES IN ^{185}Re AND ^{187}Re. Dar, Y.; Gerber, J.; Macher, A.; Vivien, J. P. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys., A137: 273-7(1969).

Relative intensities of γ-rays and conversion electrons following Coulomb excitation of the first excited states in ^{185}Re and ^{187}Re were registered. Discrepancy is found between available groups of experimental data. (auth)

3937 DIRECTIONAL ANISOTROPY OF CAPTURE GAMMA RAYS FROM ALIGNED ^{149}Sm NUCLEI. Reddingius, E. R.; Postma, H. (Kamerlingh Onnes Laboratorium, Leiden. Reactor Centrum Nederland, Petten, Netherlands). Nucl. Phys., A137: 389-416(1969).

The anisotropy of the directional distribution of neutron-capture gamma rays from aligned ^{149}Sm nuclei was measured. The ^{149}Sm nuclei were aligned in single crystals of Ce(Sm)Mg double nitrate which were cooled to about 0.01°K by adiabatic demagnetization. The following spin and parity assignments for levels of ^{150}Sm were obtained by combining the anisotropy measurements with available electron conversion data: $J^\pi(1046.4) = 2^+$, $J^\pi(1071.4) = 3^-$, $J^\pi(1165.6) = 1^-$, $J^\pi(1193.8) = 2^+$, $J^\pi(1357.7) = 3^-$, 5^-, $J^\pi(1449.3) = 4^+$, $J^\pi(1504.7) = 3^+$, $J^\pi(1642.7) = 4^+$, $J^\pi(1684.2) = 3^-$, 4^-, $J^\pi(1822) = 4^+$, $J^\pi(1843.6) = (2^+,4^+)$, $J^\pi(1951) = 3^-$, 5^-, (4^-), J(1971.9) = 4, $J^\pi(2021.5) = 4^+$, $J^\pi(2062.9) = 3^+$, (5^+), $J^\pi(2094) = 5^+$, $J^\pi(2120) = 3^-$, 5^-, $J^\pi(2153.3) = 4^+$, $J^\pi(2191.2) = 4^+$, J(2260) = 4, $J^\pi(2368) = 3^+$, 5^+, $J^\pi(2453) = 3^+$, $J^\pi(2493) = 3^+$, 5^+ and $J^\pi(2647) = 3^{(+)}$, $5^{(+)}$. These results were combined with existing data to construct an extended level scheme of ^{150}Sm. The energy level scheme of ^{150}Sm is compared to the level schemes of neighboring samarium nuclei and of ^{152}Gd. (auth)

3938 NANOSECOND ISOMERIC TRANSITIONS IN THE 89-NEUTRON NUCLEUS ^{153}Gd. Andrejtscheff, W.; Meiling, W.; Stary, F. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A137: 474-80(1969).

In ^{153}Tb decay, the half-lives of the excited states at 41.6 keV and 129.2 keV in ^{153}Gd were determined as $T_{1/2}$(41.6 keV) = 4.1 ± 0.1 ns and $T_{1/2}$(129.2 keV) = 2.50 ± 0.15 ns. Nilsson characteristics for some levels are suggested. Comparisons to Nilsson and Weisskopf estimations for γ-ray transition probabilities are performed. Conclusions about the ^{153}Gd level structure are drawn. (auth)

3939 NUCLEAR STRUCTURE STUDIES IN THE TELLURIUM ISOTOPES: THE ^{124}Te(d,p)^{125}Te REACTION. Graue, A. (Univ. of Bergen); Lien, J. R.; Roeyrvik, S.; Aaroey, O. J.; Moore, W. H. Contract AT(30-1)-2096. Nucl. Phys., A136: 513-31(1969).

The reaction ^{124}Te(d,p)^{125}Te was studied at a bombarding energy of 7.5 MeV in order to get information about the ^{125}Te nuclear level scheme. The protons were recorded simultaneously at 23 angles in a multiple-gap magnetic spectrograph. One hundred and fifty two levels were observed below an excitation energy of 6.2 MeV, and the proton angular distribution for 55 of these transitions were compared to DWBA calculations in order to determine the transferred orbital angular momentum, l_n, and to measure spectroscopic factors. The lower part of the level scheme was compared to the results from studies of ^{125}Sb decay, and to theoretical pairing-theory calculations. A sum-rule analysis of the holes in the 50 to 82 neutron shell gave 7.95 vacancies while the expected value is 10. Single-quasiparticle energies for ^{125}Te, ^{127}Te, ^{129}Te and ^{131}Te are listed. A comparison is made with the isobaric analog states in ^{125}I observed elsewhere in the ^{124}Te(p,p) reaction. (auth)

3940 THE INTERNAL CONVERSION OF THE 6-keV TRANSITION IN ^{181}Ta. Blumberg, H.; Hager, R. S.; Seltzer, E. C. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Phys., A136: 624-30(1969).

Penetration effects were observed in the M and N shell internal conversion of the 6 keV ground-state transition in ^{181}Ta. The transition energy was measured to be 6.21 ± 0.03 keV. (auth)

3941 THE ^{89}Y(p,γ)^{90}Zr, ^{88}Sr(p,γ)^{89}Y, AND ^{86}Sr(p,γ)^{87}Y REACTIONS WITH 4-MeV PROTONS. Irigaray, J. L.; Asghar, M.; Dalmas, J.; Petit, G. Y.; Roturier, J. (Univ., Bordeau). Nucl. Physics., A136: 631-40(1969).

The reactions ^{89}Y(p,γ)^{90}Zr, ^{88}Sr(p,γ)^{89}Y and ^{86}Sr(p,γ)^{87}Y were studied at 3930 keV proton energy. A pair spectrometer consisting of two NaI(Tl) crystals and a Ge(Li) diode was used to measure the γ-ray spectra. Six, four and five high-energy γ-ray transitions were observed respectively in ^{90}Zr, ^{89}Y and ^{87}Y. The energies of these transitions, the proton separation energies S_p for each of these nuclei and proton-proton pairing energies δ_p for Z = 40 were determined with high precision. The relative intensities and the values of absolute capture cross sections for various transitions were also determined. To interpret the results on ^{90}Zr, it is necessary to assume the existence of 2p-2h configurations in the capturing 1^- S = 0, L = 1; S = 1, L = 1 giant resonances. A value of 3.9 for the 2p-2h amplitude to the 1p-1h amplitude is determined. The 2^+ levels at 3293 keV and 3827 keV in ^{90}Zr are proposed to have respectively the $[(2p_{\frac{1}{2}})_p^{-2}(1g_{\frac{9}{2}})_p^2]^{[2+]}$ and $[(1f_{\frac{5}{2}})_p^{-2}(1g_{\frac{9}{2}})_p^2]^{[2+]}$ configurations. In ^{90}Zr s-wave proton capture for ^{89}Y (for ^{87}Y perhaps, also) in order to explain the results. It is suggested that this important d-wave capture may be due to the presence of the wing of a proposed proton resonance at $E_p \approx 5$ MeV, which should be an analog to the ground state of ^{89}Sr. (auth)

3942 GAMMA-RAY SPECTRUM FROM ^{183}Ta DECAY AND THE LEVEL STRUCTURE OF ^{183}W. White, D. H.; Birkett, R. E. (Univ. of California, Livermore). Nucl. Phys., A136: 657-62(1969).

The γ-ray spectrum of ^{183}Ta was measured using a Ge(Li) detector, resulting in precise energy values of previously observed transitions and the discovery of new transitions. In particular, new transitions were found at 351.03 ± 0.10 keV and 1113.38 ± 0.10 keV. The 1157 keV peak is found to be an unresolved doublet whose components are consistently assigned to the predicted transitions 1157.311 ± 0.013 keV and 1158.080 ± 0.015 keV. The transition energies are fit to the proposed level scheme by linear least-squares methods. The level scheme is discussed in the light of these results. (auth)

3943 THE DECAY OF THE 13 h ISOMER OF ^{182}Re. Galan, P. (Joint Inst. for Nuclear Research, Dubna, USSR); Galanova, T.; Malek, Z.; Voinova, N.; Preibisz, Z.; Stryczniewicz, K. Nucl. Phys., A136: 673-95(1969).

The single gamma-ray spectrum, electron-gamma and gamma-gamma coincidence spectra were studied in the ^{182m}Re → ^{182}W decay with Ge(Li) and NaI(Tl) detectors as well as with a six-gap beta-ray spectrometer. A total of 28 new gamma-ray transitions were observed and ten new levels introduced. The $J^\pi K = 2^+0$ level at 1257.5 keV was confirmed, and another level at 1538 keV with the same quantum characteristics was established. The rotational band with $K^\pi = 1^+$ based on the pp[402↑−404↓] state at 2057.5 keV was suggested. The character of the decay of the investigated ^{182m}Re (12.7 h) isomer indicates that it most probably is the {p 402↑−n 624↑} 2^+ state. (auth)

3944 ARE FISSION TRACKS IN METEORITES FROM SUPER-HEAVY ELEMENTS? Price, P. B.; Fleischer, R. L. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Lett., 30B: 246-8(Oct. 13, 1969).

The length distribution of binary fission tracks and the low ratio of ternary to binary fission tracks in several meteorites fit the original interpretation of a ^{244}Pu origin and are inconsistent with an interpretation that they were produced by fission of superheavy elements. (auth)

3945 INVESTIGATION OF THE SPECTRUM OF ^{182}W CONVERSION ELECTRONS IN HARD ENERGY RANGE. Metskhvarishvili, R. Ya.; Elizbarashvili, M. A.; Gachechiladze, V. M.; Nabichvrishvili, V. A.; Bodokiya, L. V.; Kikiani, B. I.; Kirikashvili, N. E. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 56: 53-6(Oct. 1969). (In Russian).

The spectrum of ^{182}W conversion electrons was investigated. Relative intensities of all observed conversion lines were determined. The ratios K/L for some γ-transitions were measured. A low intensity conversion line for γ-transition with energy of 763 keV was discovered. (auth)

3946 MOESSBAUER EFFECT IN ^{167}Er FOLLOWING COULOMB EXCITATION. Wilenzick, R. M.; Hardy, K. A.; Hicks, J. A.; Owens, W. R. (Tulane Univ., New Orleans). Phys. Lett., 30B: 167-8(Sept. 29, 1969).

The Moessbauer effect of the γ rays from the 79.3-keV state of ^{167}Er was observed following Coulomb excitation with 3-MeV protons. A lower limit for the half-life of the state was determined as 103 ± 6 ps. (auth)

3947 RESONANCE PARAMETER DETERMINATION OF THE MAIN RESONANCE OF INDIUM BY ACTIVATION FOILS. Fleck, Carl M. (Oesterreichische Hochschule, Vienna). Nukleonik, 12: 259-62(Oct. 1969).

Resonance parameters may be determined by means of the self-indication method with sufficient accuracy even without the use of a neutron spectrometer, as could be shown for the In-main resonance. Self-indication by variation of the temperature was used as suggested by Fleck and Weisshäupl. For this purpose, appropriate corrections had to be developed for the effect of the side resonances, the 1/v contribution and to account for the influence of the Cd-wing on the main resonance activation. The temperature-corrected parameters of the first In resonance at 1.458 eV were found to be $\Gamma = 0.073 \pm 0.003$ eV and $\sigma_r = 39{,}300 \pm 400$ b. (auth)

3948 ABSOLUTE STANDARDISATION OF ^{195}Au BY beta–gamma COINCIDENCE COUNTING. Adams, R. J. (National Research Council, Ottawa). Int. J. Appl. Radiat. Isotop., 20: 808-11 (Nov. 1969).

It is stated that absolute measurements of electron-capture decay can be achieved by conventional 4π βγ coincidence methods when the capture event is followed by prompt gamma emission. Difficulties can, however, arise if the gamma ray is not resolved from the K x ray which follows capture or K-conversion (e.g. ^{195}Au), since the coincidence to gamma channel counting ratio Nc/Nγ is no longer related to the 4π detector efficiency. The problem is, however, less complicated when the 4π counter is operated under pressure, since the higher energy events (KXY Auger, conversion, and photoelectrons) may be spectrally separated from the lower energy events for which the 4π counter responds only to L and higher orbital vacancy cascades (denoted by L^0). In addition, for high-Z species the detection probability for L^0 events will be increased by pressurizing, due to enhanced absorption of L x rays in the gas. This approach is applied to the calibration of ^{195}Au, and studies are described which establish the applicability of the general methods of measurement for complex decay to the case of ^{195}Au. It appears that systematic errors intrinsic to the coincidence method for ^{195}Au, including data fitting but excluding source preparation, should not exceed 0.1%. The effects of energy degradation arising from foil absorption and the influence of increased source self-absorption were examined. It appeared that the physical state of the source is not critical and that rather severe source energy degradation can be tolerated. (UK)

3949 FORM OF THE SPECTRA OF THE 1510-keV β TRANSITION AND SPIN OF ^{152}Eu^{m1}. Andre, S.; Liaud, P.; Perales, F.; Van Der Werf, S. Y. (Centre d'Etudes Nucleaires, Grenoble, France). Phys. Lett., 30B: 160-1(Sept. 29, 1969). (In French).

The beta spectrum of the decay of ^{152}Eu^{m1} (9.3 h) to the first excited state of ^{152}Gd is found to have the "unique" shape, providing strong additional evidence that the spin of the initial state is 0^-. (auth)

3950 PURE FERMI TRANSITION IN THE BETA DECAY OF ^{156}Eu. Nielsen, H. L.; Rud, N.; Wilsky, K. (Univ. of Aarhus, Denmark). Phys. Lett., 30B: 169-70(Sept. 29, 1969).

Angular correlation measurements yield $J^\pi = 0^+$ for the 1168-keV level in ^{156}Gd; ^{156}Eu (0^+) is found to beta decay by a Fermi transition to the 1168-keV 0^+ state with a strength almost twice that of the ground-state decay. (auth)

3951 MOESSBAUER EFFECT FOLLOWING COULOMB EXCITATION MEASUREMENTS OF ELECTRIC QUADRUPOLE MOMENT RATIOS IN THE FIRST EXCITED 2^+ STATES OF ^{182,184,186}W. Chow, Y. W.; Greenbaum, E. S.; Howes, R. H.; Hsu, F. H. H.; Swerdlow, P. H.; Wu, C. S. (Columbia Univ., New York). Phys. Lett., 30B: 171-4(Sept. 29, 1969).

The following ratios of quadrupole moments in the first excited 2^+ state of ^{182,184,186}W were measured simultaneously using the Moessbauer effect following Coulomb excitation: 1 : (0.930 ± 0.016) : (0.908 ± 0.024). Single crystals of WS_2 were used as the absorbers. These results are compared with the rotational model and the calculations of Kumar and Baranger. (auth)

Nuclear Theory

Refer also to abstracts 3550, 3689, 3773, 3848, 3861, 3865, 3866, 3869, and 3908.

3952 (ORO-3765-22) PROGRESS REPORT FOR THEORETICAL STUDIES IN NUCLEAR REACTIONS AND STRUCTURE. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Sept. 1969. Contract AT(40-1)-3765. 18p. Dep. CFSTI.

The research results of the nine month period from January 1, 1969 to date are summarized. Hartree-Fock and shell model studies of nuclear structure continued and several quantitative applications to specific nuclei were completed. Study of the nuclear many-body problem intensified. In the area of reaction theory, the unified shell model theory found detailed application to several nuclei and further study of analog resonances in this framework was completed. The effort devoted to reactions involving elementary particles grew last year, as did the attention paid to a variety of three-body reaction problems. The possible role of rapid collective motion as a determinant for nuclear fission was further clarified. (auth)

3953 (ORNL-4433) NEUTRON PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1969. (Oak Ridge National Lab., Tenn.). Sept. 1969. Contract W-7405-eng-26. 133p. Dep. CFSTI.

ALUMINUM-27—proton inelastic scattering at 61 MeV; differential cross sections for (E)
COPPER—photon reactions at 50 to 400 MeV, neutron and pion yield from (T)
FISSION—cross sections for subthreshold, structure of, (T)
GAMMA RADIATION—dose rate from 200-MeV proton reactions on iron (T)
IRON-56—neutron inelastic scattering at MeV energies, cross-section calculations using HELENE and JULIE codes
LINEAR ACCELERATORS—experimental facilities at ORELA, development of liquid scintillation tank
LITHIUM-7—proton reactions (p,n) at 20 to 40 MeV, neutron time-of-flight spectra for (E)
NEUTRON SPECTROMETERS—response function calculations for proton recoil, with active radiator
NIOBIUM-92—energy level at 226 keV, lifetime for (E)
NIOBIUM-94—energy level at 140.4 keV, lifetime for (E)
NUCLEAR REACTIONS—R-matrix for, variation of (T)
NUCLEI—meson (π) reaction with, analysis using two-step cascade and evaporation model (T)
OXYGEN-16—neutron reactions (n,xγ) at 6.7 to 11 MeV, γ spectra for (E)
—proton inelastic scattering at 50 MeV, calculation of γ spectra from (T)
RADIATION DETECTORS, SCINTILLATION—development of liquid, at ORELA
—calibration of NE-213 liquid, with 40-MeV neutrons
—light output of NE-213 liquid, for 40-MeV protons
SHIELDING—calculations using discrete ordinates method, comparison with neutron and γ-ray slab transmission data
—design study for space station
—design study for missile silo cover
TIN-120—proton elastic scattering at 10 to 40 MeV, optical-model analysis of (E/T)
TUNGSTEN—neutron capture by, DUCAL calculation of γ yield from thermal
URANIUM-235—neutron absorption by, γ energy spectra above 1 MeV from thermal (E)
URANIUM-238—neutron inelastic scattering at MeV energies, cross-section calculations using HELENE and JULIE codes
YTTRIUM-89—proton inelastic scattering at 61 MeV, differential cross sections for (E)
ZINC-64—deuteron reactions (d,n) at 10 MeV, neutron time-of-flight spectra for (E)
ZINC-66—deuteron reactions (d,n) at 10 MeV, neutron time-of-flight spectra for (E)
ZINC-68—deuteron reactions (d,n) at 10 MeV, neutron time-of-flight spectra for (E) (T.W.R.)

3954 A STUDY OF LIGHT 4n NUCLIDES EMPLOYING A THREE-PART GAUSSIAN INTERACTION. Ruehl, Franklin R. Jr. (Univ. of California, Los Angeles). Nucl. Phys., A136: 241-56(1969).

The properties of the light 4n doubly even nuclides ranging from ^{4}He to ^{40}Ca are studied in a simple restricted Hartree-Fock calculation, employing an effective three-part two-body nucleon-nucleon interaction. This interaction consists of a trio of Wigner plus Majorana exchange forces each having Gaussian radial dependence. A rectangular harmonic oscillator basis of states is utilized. Two classes of parameter sets are studied: one generated from fitting the ground state energy and root-mean-square radius of ^{4}He and ground state energy and density of nuclear matter, and one obtained from fitting the ground state energy and root-mean-square radius of both ^{4}He and ^{40}Ca. The resulting parameters are used to compute the ground state binding energies and harmonic oscillator energies of seven nuclides, ^{8}Be, ^{12}C, ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, and ^{36}Ar, treated as being axially symmetric, with two possible configurations for all but ^{8}Be and ^{12}C considered. Moreover, ^{28}Si is also analyzed as a spherically symmetric nuclide. Additionally, the deformations of the axial nuclides are determined. (auth)

3955 SIMULATED CORE POLARIZATION IN THE LEAD REGION. Freed, N.; Gibbons, J. (Pennsylvania State Univ., University Park). Nucl. Phys., A136: 423-32(1969).

The dominant effects of core polarization in the lead region are simulated by a simple residual interaction of the pairing-plus-quadrupole type. The direct-interaction matrix elements are generated by the nonlocal Tabakin potential with second-order Born terms included. Results of calculations are compared to predictions made with a slightly modified Tabakin potential and with the two-body matrix elements of Elliott. Possible origins of this modification are discussed. (auth)

3956 MODEL FOR CALCULATING THE ANGULAR MOMENTUM DISTRIBUTION OF FISSION FRAGMENTS. Rasmussen, J. O. (Yale Univ., New Haven); Noerenberg, W.; Mang, H. J. Nucl. Phys., A136: 465-80(1969).

A scheme is presented for quantitative calculations of the distribution of rotational angular momenta in primary fission fragments. The wave function of the bending mode excitation at the scission point is expanded in angular momentum components. As an example, the distribution of rotational angular momentum is estimated for the fragment of mass 108 from the thermal neutron fission of ^{239}Pu. The experimental literature on the subject is reviewed. (auth)

3957 NUCLEAR SYMMETRY ENERGY OF FINITE NUCLEI AND INFINITE NUCLEAR MATTER. Weiss, Richard Arthur. New York, New York Univ., 1968. 442p.

Thesis.

The nuclear symmetry energy is calculated for infinite nuclear matter and for finite nuclei by applying the simple many-body formalism of the Hartree-Fock forward and exchange scattering approximation to a strongly interacting system of neutrons and protons. This is done by calculating the binding energy per nucleon as a function of total density and nucleon composition. In this way a series of generalized nuclear matter curve is determined which indicates that a natural consequence of the nuclear interactions is the decrease of the saturation density with increasing neutron excess. These curves determine the NUCLEAR MATTER EQUILIBRIUM CURVE, which is the locus of the saturation points of the nuclear matter curves of different compositions. On this curve the density and binding energy per nucleon are functions of the neutron excess only. From this it follows that for a strongly interacting system of nucleons, the average kinetic energy per nucleon decreases with increasing neutron excess above the N = Z condition. The nuclear symmetry energy is immediately obtained from the equilibrium curve because its slope and curvature determine directly the second and fourth order symmetry energy coefficients. The negative sign of the fourth order coefficient follows from the negative curvature of the equilibrium curve and is directly related to the nuclear compressibility, but is also part of a more general scheme whereby in accordance with Le Chatelier's principle the symmetry energy coefficients have alternating signs. A method of measuring the nuclear compressibility by means of nuclear mass formulas is presented as a replacement for the present method of obtaining this quantity based on the isotope shift effect which is found to be actually not related to nuclear compressibility. A general equilibrium theory of finite nuclei is developed from which a nuclear symmetry energy is calculated whose coefficients are not constants but are functions of the mass number. Applications to a nuclear mass formula are considered. Finite nuclei equilibrium curves are developed which are analogous to the equilibrium curve for infinite nuclear matter. From these curves it is clear that there is a negative ISOSPIN COMPRESSION ENERGY which explains why conventional nuclear mass formulas tend to underestimate the binding energy of nuclei in the region of large neutron excess. The methods used for calculating the binding energy of neutron-proton systems are generalized to the case of an arbitrary number of different spin ½ baryons, and generalized Euler statistical factors have been developed for this purpose. Baryon matter saturation curves are presented. (Disser. Abstr.)

3958 ELECTROMAGNETIC SIMULATION OF TIME REVERSAL VIOLATION IN BETA DECAY. Chen, Herbert Hwa-sen. Princeton, N. J., Princeton Univ., 1968. 145p.

Thesis.

In the absence of final state interactions, time reversal invariance prohibits the existence of triple product correlations in beta decay spectra. An example of a triple product correlation is $\langle\vec{\sigma}:\rangle \cdot (\vec{P}e \times \vec{P}_\nu)/(E_e E_\nu)$ where $\langle\vec{\sigma}:\rangle$ is the polarization of the decaying particle, and $\vec{P}_e$ (E_e) and $\vec{P}_\nu$ (E_ν) are the momenta (energies) of the charged lepton (electron or muon) and neutrino respectively. Either the existence of final state interactions or a violation of time reversal invariance will give rise to triple product correlations. For three body semi-leptonic decays, the final state interaction is electromagnetic, so the induced correlation is small. Therefore the attempted measurements of triple product correlations in these decays constitute a test of T-invariance (T is the operation of time reversal), and the electromagnetically induced correlations are considered a simulation of T-violation. Calculations were performed for the effect of electromagnetic final state interaction for D, the coefficient of the above explicitly mentioned triple product correlation, which is the polarization of the decaying particle normal to the plane of decay in the limit $m_e = 0$ (m_e is the mass of the electron or muon), in two cases: The semi-leptonic decay of spin ½ hyperons, an example is $\Sigma^- \rightarrow ne\bar{\nu}$; and the beta decay of spin ³/₂ mirror nuclei, an example is $^{35}A \rightarrow {}^{35}Cl e^+\nu$. For the case of hyperon beta decay, it is shown that a measurement of D without T-violation constitutes a sensitive means of detecting induced recoil dependent form factors of the vector and axial vector current. The induced pseudo-tensor form factor is an example. For the beta decay of a spin ³/₂ mirror nucleus, it is shown that D is dominated by weak magnetism. This was shown previously by Callan and Treiman in the beta decay of a mirror spin ½ nucleus. A measurement of D in the absence of T-violation, then, constitutes a test of the Conserved Vector Current Theory. In general, the magnitude of D generated by electromagnetic final state interactions will be very small, i.e., $\leq 10^{-3}$. However in one special decay mode, $\Sigma^- \rightarrow \Sigma^0 e^- \bar{\nu}$, it is shown that due to the presence of the alternate decay mode of Σ^-, $\Sigma^- \rightarrow \Lambda^0 e^- \bar{\nu}$, and the existence of a $\Sigma^0 \rightleftharpoons \Lambda^0$ transition magnetic moment, this triple product correlation becomes much larger. D, the polarization of the decaying particle normal to the decay plane in the limit $m_e = 0$, is estimated to be of the order 10^{-2}. (Disser. Abstr.)

3959 GROUP-THEORETICAL ANALYSIS OF NUCLEAR STATES IN SOME $j = 3/2$ SHELLS. Camiz, P. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Cattani, U. Nuovo Cim., 64B: 56-81(Nov. 11, 1969).

The energy levels of nuclei in the shells $1p_{\frac{3}{2}}$, $1d_{\frac{5}{2}}$ and $2p_{\frac{3}{2}}$ are described by a group-theoretical mass formula deduced from the hypothesis of pure $(j)^n$ configurations in the seniority scheme. The residual interaction between nucleons is decomposed into the pairing term (J = 0, T = 1), the isopairing term (J = odd, T = 0) and a $J \neq 0$, T = 1 term; Coulomb interaction between protons is accounted for in a schematic way. The corresponding coupling constants, together with single-particle energies, are treated as free parameters to be adjusted by a least-square fit to experimental data. Deviations between experimental and calculated energies are analyzed in order to test the validity of the proposed symmetry scheme in the three shells considered, and to discuss its possible improvements. (auth)

3960 A CONSISTENT FIELD-THEORETIC PERTURBATIVE CALCULATION TO $Z\alpha$ OF CORRECTIONS TO THE FERMI FUNCTIONS. Halpern, Todd Allen. Gainesville, Fla., Univ. of Florida, 1968. 158p.

Thesis.

A unified and consistent treatment of the atomic electron screening, finite nuclear size, and static vertex radiative corrections to the point nucleus Fermi function is presented. A field-theoretic perturbation approach is employed to develop the point nucleus Fermi function to first order in $Z\alpha$ and all of the above mentioned corrections to it. Because of the important role played by $0^+ \rightarrow 0^+$ positron decays in the determination of the vector coupling constant G_V^β, the work presented here is specialized to these decays. Previous calculations of the corrections to the Fermi function have been done in a somewhat fragmentary way and it is difficult to see all the corrections in a proper perspective. The perturbation approach used here brings out the relative importance of these corrections. It was possible to separate out the exact point nucleus Fermi function and thus treat only the corrections in perturbation theory. The finite nuclear size and first-order static vertex radiative corrections are expressed analytically in terms of arbitrary daughter nucleus charge distributions and probability densities for the decaying nucleon. A simple Yukawa model is used to obtain an analytical result for the atomic electron screening correction. These expressions are used to study the nuclear model dependence of the finite nuclear size and first-order static vertex radiative corrections. Previous treatments of these corrections are examined for consistency with each other. This is done by considering various representative nuclear models in the corrections. The most realistic model chosen employs the nuclear charge distributions as given by Hofstadter and the single particle harmonic oscillator shell model for the nuclear matrix elements. The analytical model dependent results are then used to calculate the corrections to the ft values of the superallowed $0^+ \rightarrow 0^+$ positron decays of ^{14}O, ^{26m}Al, ^{34}Cl, ^{42}Sc, ^{46}V, ^{50}Mn, and ^{54}Co. The ft values and vector coupling constants G_V^β are calculated for the nuclei using the most realistic model, and the variation of G_V^β among the nuclei is discussed in the light of the predictions of the conserved vector current theory of weak interactions. The following results were found. To first order in $Z\alpha$, the atomic electron screening correction agrees exactly with Rose's W. K. B. approximation. For the heavier nuclei considered (A > 34), the finite nuclear size corrections calculated in this dissertation are as much as 1% of f_0t lower than those that have been previously quoted in the literature. This is in agreement with the conclusions of several recent papers dealing with calculations of electron radial wave functions. The nuclear model dependence of the finite nuclear size correction is negligible for ^{14}O and ^{26m}Al. For ^{34}Cl, ^{42}Sc, ^{46}V, ^{50}Mn, and ^{54}Co, the variation of the finite nuclear size correction due to the use of different models previously used in the literature is comparable to the screening correction. In view of this last finding, a more precise calculation of finite nuclear size correction has been made in which the Hofstadter charge densities have been used for the daughter nuclei, and the single particle harmonic-oscillator shell model has been used for the wave function of the decaying proton. For all of the decays considered in this work, the variation of the first-order static vertex radiative correction due to the use of different nuclear models was found to be as much as 1% of f_0t. However, the Hofstadter-Harmonic Oscillator nuclear model gave results close to those given by Chern et al. for the finite de Broglie wavelength model. (Disser. Abstr.)

3961 COMPARISON OF THE USUAL FERMI FUNCTION FOR A POINT NUCLEUS WITH A FIELD THEORETIC PERTURBATIVE CALCULATION TO $Z^2\alpha^2$. Logue, Laurence Joseph. Gainesville, Fla., Univ. of Florida, 1968. 78p.

Thesis.

Considerable attention has recently been given to obtaining accurate calculations of the Fermi function which is used in the determination of the vector coupling constant, G_V, for nuclear beta decay, since this coupling constant is important in assessing the problem of universality in the weak interactions. A simple model which explicitly embodies the change in nuclear charge due to the beta decay is used to develop the point nucleus Fermi function (for the daughter nucleus) in perturbation theory to order $Z^2\alpha^2$, and the corrections to it arising due to the change in charge. The Coulomb interaction between the electron and the static parent-daughter nucleus is calculated allowing for pair creation. This model has been used by Chern, Halpern and Logue and by Halpern and Chern to obtain analytical model dependences of the finite nuclear size, screening, and static beta vertex corrections to first order in α. It is shown that the divergences in the Fermi function have the same source as the divergences occurring in this model due to the change in nuclear charge, so that both types of divergence must be treated in the same manner, including the use of the same cutoff. These latter divergences would also appear in a complete treatment of the radiative correction. The $Z\alpha^2$ contribution to the radiative correction from this model is comparable to the atomic electron screening correction and thus must be included if one takes the screening into account. An uncertainty has arisen in the literature concerning the incorporation of the first-order radiative correction into the Fermi function. The approximate factorization previously used in the literature to order α is also valid to order α^2 for nuclei with Z less than that of ^{26}Al. The validity of this factorization for higher Z is still unresolved. (Disser. Abstr.)

3962 SPECTROSCOPIC ANALYSIS OF SINGLE-PARTICLE TRANSFER REACTIONS IN THE SU_3 SCHEME. Stewart, K. W. C.; Castel, B. (Queen's Univ., Kingston, Ont.). Can. J. Phys., 47: 2004-7(Sept. 15, 1969).

Spectroscopic factors for single-particle exchange reactions are calculated in the SU_3 model. As a first approximation, each state is described by only one SU_3 representation. Agreement with experiment is found to be as good as for the more complicated versions of the Nilsson and shell models. (auth)

3963 RELATION BETWEEN THE 2I + 1 RULE AND LEVEL WIDTH. Hsu, Chu Chung (National Tsing Hua Univ., Taiwan). Phys. Rev., 184: 1020-1(Aug. 20, 1969).

An additional condition necessary for the 2I + 1 rule to be valid is found: The total level width Γ_μ must be large enough so that the width-fluctuation correction factors F for final states will be approximately equal. Feshbach's formula, corrected by the width-fluctuation correction factor, is used in discussing the dependence of the cross sections on the average total level width, average partial widths of final states, and the spin cutoff parameter. It is shown that the 2I + 1 rule is obeyed, in addition to MacDonald's three conditions, if the F's are approximately equal for all final states, which requires a sufficiently large Γ_μ. (auth)

3964 ELECTROMAGNETIC AND WEAK EXCITATION OF A SYSTEM OF OVERLAPPING NUCLEAR RESONANCES AND THEIR SUBSEQUENT DECAY. Crone, Lawrence Joseph Jr. Washington, D. C., Catholic Univ. of America, 1968. 66p. Thesis.

The problem of the angular correlation of nuclear fragments following energy and momentum transfer to the nucleus from photo-absorption, electron scattering, and muon capture is dealt with. In particular, the giant dipole region of nuclear excitation, where it is meaningful to describe the nuclear system by a collection of overlapping resonances, is studied using R-matrix theory to parametrize the resonances and perturbation theory to lowest order to calculate transition matrix elements. Numerical calculations are made for the case of ^{4}He using harmonic oscillator wave functions to evaluate the electromagnetic and weak interaction matrix elements. Results for two level schemes which have been proposed previously are compared with experimental data, and it is seen that one gives a much better fit to the photo-absorption cross section. (Disser. Abstr.)

3965 STRUCTURE OF ^{18}F AND ^{18}O. Zuker, Andres P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 23: 983-7(Oct. 27, 1969).

A detailed shell-model description of ^{18}F and ^{18}O is given for all levels of known spin and parity. New assignments are suggested. It is shown that a weak-coupling model is highly successful in reproducing the exact results. (auth)

3966 MAGNETIC MOMENT MEASUREMENTS FOR SHORT-LIVED NUCLEAR STATES. Hrynkiewicz, Andrzej Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Nukleonika, 14: 427-45(1969).

A general review of methods used for measuring magnetic moments of short-lived nuclear states is given. Principles, possibilities and limitations of the methods based on the Moessbauer effect and on angular correlations of nuclear radiations are presented in more detail and some recent methodical refinements are described. (auth)

3967 COULOMB AND VACUUM POLARIZATION INTERFERENCE EFFECTS FOR $^1S_0$ p-p NUCLEAR POTENTIALS. Kermode, Mark W.; Sprung, Donald W. L. (McMaster Univ., Hamilton, Ont.). Nucl. Phys., A135: 535-44(1969).

The addition of vacuum polarization to a number of well-known $^1S_0$ p-p potentials is considered. On the basis of the results a simple method to incorporate the vacuum polarization effect explicitly in the construction of phenomenological potentials is suggested. A new potential which reproduces the experimental phase shifts well is introduced. The n-n effective range parameters are considered. (auth)

3968 ESTIMATE OF THE FIRTSEVSKII TERM FROM DATA ON O^+–O^+ BETA TRANSITIONS. Lyutostanskii, Yu. S. Yadern. Fiz., 10: 198-9(July 1969). (In Russian).

The Firtsevskii term is an interference term that is found in an expression for the spectrum of allowed beta transitions. The presence of this term is deduced from the nonlinearity of the Kurie plot at low beta energies. However, experimental data in this region for positron O^+–O^+-transitions are not sufficiently accurate. This term has been found only for three nuclei. This term is calculated from values of the maximum beta energy W_0, lifetime t, and ft values of the Kurie plot for the following isotopes: ^{14}O, ^{26}Al, ^{34}Cl, ^{42}Sc, ^{46}V, ^{50}Mn and ^{54}Co. The value of the Firtsevskii term B_F was found to be 0.011 ± 0.019, and tends toward zero if ^{26}Al is excluded from consideration. Then B_F is found to be 0.003 ± 0.018. It would be desirable to obtain a more accurate value of ft for ^{26}Al. In addition, an exact measurement of positron decay in ^{10}C (O^+–O^+-transition) would give much information on the magnitude of this term. (TTT)

3969 INVESTIGATION OF THE DENSITY DISTRIBUTION OF NUCLEI, TAKING INTO CONSIDERATION THE RADIAL KINETIC SELF-ENERGY CORRECTION. Tisza, M. Acta Phys. Acad. Sci. Hung., 26: 247-59(1969).

Based on the statistical model of the nucleus developed by P. Gombás the proton and neutron density of nuclei is determined. By the statistical perturbation method the radial kinetic self-energy correction is taken into account and the extent to which the density distribution is altered by this correction is investigated. The density is calculated for three nuclei and the results are used for the determination of the nuclear form factors. (auth)

3970 EXACT AND APPROXIMATE ANGULAR MOMENTUM PROJECTION FOR LIGHT NUCLEI. II. Lamme, H. A.; Boeker, E. (Vrije Univ., Amsterdam). Nucl. Phys., A136: 609-23(1969).

The Peierls–Yoccoz angular momentum projection method is applied to axially symmetric Hartree–Fock wave functions for several sd-shell nuclei. Excitation energies, rms radii and B(E2; $2^+ \rightarrow 0^+$) values are calculated and compared with the results of two different approximation methods. This is also done for some ^{12}C wave functions considered earlier. A discussion of the accuracy of these approximations is given. An approximate formula for the B(E2; $2^+ \rightarrow 0^+$) value is presented, which gives much better agreement with the exact angular momentum projection results than the formula from the Bohr–Mottelson model. (auth)

3971 STUDIES IN THE NUCLEAR CLUSTER MODEL. II. TWO-CLUSTER CONFIGURATIONS. Kramer, P.; Seligman, T. H. (Univ., Tuebingen, Ger.). Nucl. Phys., A136: 545-63(1969).

Configurations of two clusters are analyzed and adapted to orbital symmetry. Using the concept of double coset generators, basic integrals for normalization and for the application of two-body operators are determined and classified according to their exchange type. The normalization and the two-body matrix elements for symmetry-adapted states are written as linear combinations of basic integrals. The coefficients in these linear combinations are given explicitly. (auth)

3972 TREATMENT OF THE THREE-NUCLEON PROBLEM BASED ON THE SEPARABLE EXPANSION OF THE TWO-PARTICLE t-MATRIX. Kharchenko, V. F.; Petrov, N. M. (Inst. of Physics, Kiev). Nucl. Phys., A137: 417-36(1969).

Using the separable expansion of the two-particle t-matrix the three-body problem is considered in the case of negative total energy of the three-particle system. By expansion of the wave function for the system in terms of angular functions the Faddeev equations are reduced to an infinite set of coupled one-dimensional integral equations which may be cut off for finite-range forces. The system of three identical zero-spin particles and the three-nucleon system are considered. The triton binding energy and the neutron deuteron-scattering lengths are calculated in the case of the local Hulthén potential. (auth)

3973 THREE-NUCLEON PROBLEM WITH THE SQUARE-WELL POTENTIAL. Kharchenko, V. F.; Storozhenko, S. A. (Inst. of Physics, Kiev). Nucl. Phys., A137: 437-44(1969).

On the basis of the separable expansion for the two-particle t-matrix (the Hilbert–Schmidt expansion) the problem of three nucleons, the interaction between which is described by the central square-well potential, is considered. The triton binding energy and the neutron-deuteron scattering lengths are calculated. (auth)

3974 SEPARABLE STRUCTURE OF A SELF-CONSISTENT POTENTIAL IN THE REACTION-MATRIX THEORY OF NUCLEI. Stingl, Manfred M.; Kirson, Michael W. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A137: 289-317(1969).

The currently accepted diagram-cancellation prescription for the single-particle potential in the reaction-matrix theory of finite nuclei is studied. It is shown that, under very general and weak assumptions, the potential defined by this prescription is a Hilbert–Schmidt operator of finite rank (a "separable" potential). Its individual "form factors" are closely related to the wave functions of the occupied states. All unoccupied states belong to the continuous spectrum. The structure of these continuum states is exhibited in an exact closed form which is determined uniquely by the A occupied states and represents a solution to the "orthogonalized plane wave" problem of Brueckner–Hartree–Fock theory. Using the harmonic-oscillator approximation for occupied-state wave functions (but not energies), closed analytic expressions are derived for the continuum wave functions, and quantitative results are presented on their deviations from plane waves as a function of energy. The nuclear-matter approximation for the Pauli projection operator is derived without reference to nuclear-matter concepts, and numerical values of the effective Fermi momentum are presented. The finite-rank Hilbert–Schmidt property is shown

to persist in a good approximation even for certain extensions of the potential definition considered here. The advantages of using finite-rank models for the single-particle potential in nuclear-reaction theories are discussed. (auth)

3975 HARTREE–FOCK CALCULATIONS IN THE s-d SHELL WITH REALISTIC AND SEMI-REALISTIC INTERACTIONS. Wong, S. K. M.; LeTourneux, J.; Quang-Hoc, N.; Saunier, G. (Univ., Montreal). Nucl. Phys., A137: 318-30(1969).

HF calculations with configurations restricted to the s-d shell were performed for axially symmetric nuclei with renormalized matrix elements derived from various realistic and semi-realistic interactions. The results for binding energies and projected spectra compare favorably with those obtained so far with completely phenomenological effective interactions. (auth)

3976 ON THE FISSIONING HOT COMPOUND NUCLEUS. Jaegare, S. (Research Inst. for Physics, Stockholm). Nucl. Phys., A137: 241-61(1969).

A statistical model for fissioning nuclei having double-humped fission barriers is discussed. Some of its formal consequences are studied and the importance of a correct definition of the average compound nuclear width is stressed. The model is applied to a discussion of the induced fission process and to the population of fission isomers in (n,γ) and (p,n) reactions from which valuable information on the fission barriers can be obtained. (auth)

3977 EFFECT OF CORRELATIONS ON COHERENT AND INCOHERENT PROCESSES IN NUCLEI. Von Bochmann, G. (Deutsches Elektronen-Synchrotron, Hamburg); Margolis, B.; Tang, C. L. Phys. Lett., 30B: 254-6(Oct. 13, 1969).

The results of calculating the effect of correlations in the nuclear wave function on elastic and inelastic scattering of high energy hadrons are described. One can also make use of these results to calculate coherent and incoherent photo-production processes. (auth)

3978 SENIORITY FOR NUCLEONS IN $j = 9/2$ ORBITS. Lanford, W. A. (Univ. of Rochester, N. Y.). Phys. Lett., 30B: 213-15(Oct. 13, 1969).

Using the results of some recent experiments, the goodness of seniority for identical nucleons in the $1g_{9/2}$, $1h_{9/2}$, and $2g_{9/2}$ orbits is investigated. With the present level assignments the $J = 9/2$ $v = 1$ and $v = 3$ states of $(9/2)^3$ are calculated to be admixed with an intensity less than $1/10$ of one per cent. A residual interaction which exactly preserves seniority is seen to give a two-body spectrum which has a root-mean-squared deviation from the experimental levels of less than 16 keV for these cases. (auth)

3979 RESTORATION OF ROTATIONAL SYMMETRY FOR TRIAXIAL HARTREE–FOCK SOLUTIONS. Giraud, B.; Sauer, P. U. (Carnegie Mellon Univ., Pittsburgh). Phys. Lett., 30B: 218-20(Oct. 13, 1969).

A variational principle is used to extract states of good angular momentum from intrinsic wave-functions which are not axially symmetric. It generates a diagonalization between bands on top of the usual projections. The procedure is applied to the triaxial Hartree-Fock solution for ^{24}Mg. The resulting spectrum is too much compressed with respect to the experimental one. (auth)

3980 NONPERTURBATIVE TREATMENT OF THE P_3 DEGREE OF FREEDOM OF THE NUCLEAR POTENTIAL AT EQUILIBRIUM AND FISSION DISTORTIONS. Moller, P. (Lund Inst. of Tech., Sweden); Nilsson, S. G.; Sobiczewski, A.; Szymanski, Z.; Wycech, S. Phys. Lett., 30B: 223-7(Oct. 13, 1969).

Nuclei between Th and Cf exhibit strong asymmetry in the mass distribution of their fission fragments. It has been suggested that this effect in part reflects an instability of the static potential-energy surface with respect to fission distortions. To investigate this possibility the P_3 degree of freedom is incorporated into the nuclear field. The results indicate an increased tendency to P_3 distortions at large elongations. (J.W.R.)

3981 INTERPRETATION OF AUXILIARY POTENTIAL METHOD FOR DEDUCING NUCLEAR MATRIX ELEMENTS FROM N–N SCATTERING DATA. Ley Koo, E.; De Llano, M. (Univ., Mexico City). Phys. Lett., 30B: 228-30(Oct. 13, 1969).

The auxiliary potential method is interpreted as a many-body problem in terms of the "healing" phenomenon of the Brueckner theory. Further it is shown that off-diagonal elements cannot be deduced from phase-shift data alone. (auth)

3982 NEW THEORETICAL METHOD FOR THE STUDY OF THE PHASE TRANSITION FROM SPHERICAL TO DEFORMED NUCLEI. Dreizler, R. M.; Klein, A. (Univ. of Pennsylvania, Philadelphia). Phys. Lett., 30B: 236-9(Oct. 13, 1969).

A model of the phase transition from spherical to deformed nuclei is studied in terms of a variational method for the ground state energy. The latter is expressed in terms of physically observable matrix elements. (auth)

3983 INTERACTION OF HIGH-ENERGY γ QUANTA AND ELECTRONS WITH NUCLEI. Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zk. Eksp. Teor. Fiz., 57: 1306-23(Oct. 1969). (In Russian).

It is shown that if the longitudinal distances which are important in electromagnetic interactions of hadrons linearly grow with the energy, then in interactions between high energy γ quanta and nuclei, only nucleons on the surface of the nucleus participate and the total cross section for hadron processes, σ_γ, involving heavy nuclei is $2\pi R^2 (1 - Z_3)$, where Z_3 is the photon Green function renormalization constant. $1 - Z_3$ the probability for virtual transformation of a γ quantum into hadrons. The corrections due to volume absorption of γ quanta and the case when the longitudinal distances increase at a slower rate with increase of energy are discussed in detail. (auth)

3984 ON THE VALIDITY OF THE RANDOM PHASE APPROXIMATION FOR A SOLVABLE NUCLEAR MODEL. Mann, A.; Nissimov, H.; Unna, I. (Hebrew Univ., Jerusalem). Phys. Lett., 30B: 133-5(Sept. 29, 1969).

The validity of the RPA for a slight variation of the well-known Lipkin model is investigated. Contrary to previous conclusions, it is found that the standard RPA may yield good results even for higher excited states, while perturbation theory and the renormalized RPA yield poorer results. (auth)

3985 POLOLOGY AND THE BEHAVIOR OF PARTIAL-WAVE AMPLITUDES FOR ONE-NUCLEON-TRANSFER REACTIONS. Tanifuji, M. (Hosei Univ., Tokyo); Yazaki, K. Phys. Lett., 30B: 140-2(Sept. 29, 1969).

From pololocical considerations on (d,p) reactions, it is suggested that the L-space for the partial-wave amplitude can be divided into three regions, namely, CWBA-, DWBA- and compound regions. Such a division seems to be helpful in the examination of the validity of DWBA. (auth)

3986 APPLICABILITY OF THE IMPULSE APPROXIMATION TO REACTIONS OF QUASI-ELASTIC SCATTERING. Meboniya, D. V. (Tbilisi State Univ., USSR). Phys. Lett., 30B: 153-4(Sept. 29, 1969).

Support for the "prior form" of the impulse approximation is obtained from the Faddeev equations. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 2273, 2309, 2356, 2358, 2914, 4073, and 4080.

3987 (AEC-tr-7092) HOLD-UP TIME OF THE RADIOACTIVE GASEOUS MIXTURE IN THE OFF-GAS SYSTEM DELAY SECTION. van Waveren, N. J. (comp.) (Technische Hogeschool, Delf (Netherlands)). Translation of a German report. 25p. Dep. CFSTI.

Calculations were performed to determine the minimum hold-up time for the Gundremmingen power plant turbine condenser off-gas system. The calculated results were in good agreement with measured values. An effective nuclear decay time is defined for the system, using the results of the measurements. (H.D.R.)

3988 (DUN-SA-122(Draft)) FIRE ENGINEERING FOR NUCLEAR PLANTS. Crose, H. C.; Hoffman, R. C. (Douglas United Nuclear, Inc., Richland, Wash.). Oct. 27, 1969. Contract AT(45-1)-1857. 22p. (CONF-691102-2). Dep. CFSTI.

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

Fire protection for nuclear power plant control rooms, electrical systems, electronic systems, and associated wiring is discussed. Methods for controlling fire damage through plant design, training programs, and planning are described. Combustion characteristics of materials used in controls, instrumentation, and wiring are examined, and fire control and extinguishing agents are evaluated. Backup fire protection for essential plant controls and systems is discussed. (H.D.R.)

3989 (GAMD-9450) REPORT ON TEST PROGRAM ON GAS-BEARING COMPRESSOR FOR THE HELIUM PURIFICATION SYSTEM OF THE FORT ST. VRAIN PLANT. Webb, G. B. (Gulf General Atomic, Inc., San Diego, Calif.). June 30, 1969. Contract AT(04-3)-633. 60p. Dep. CFSTI.

A regenerative, gas-bearing, motor-driven, hermetically-sealed compressor to circulate helium primary coolant from the reactor through the helium purification system and back to the reactor was tested. The test series included: determination of head-flow characteristic curves, operation in pure helium under various pressure and flow conditions, overspeed test of the impeller, casing hydrostatic pressure test, helium leakage test, start-stop cycling, and transient pressure tests. The compressor and results of the test program are described. (H.D.R.)

3990 (IEA-142) NUCLEAR POWER STATIONS OF NATURAL OR ENRICHED URANIUM COMPARISON OF THE EXPENDITURES IN FOREIGN CURRENCY UNDER BRAZILIAN CONDITIONS. Amaral, R.; Bodea, E.; Hehl, Wilma S. C.; da Rocha, R. O. Borges; de Toledo, P. Saraiva (Instituto de Energia Atomica, Sao Paulo (Brazil)). June 1967. 42p. Dep. CFSTI (U. S. Sales Only).

Economics for and cost aspects of power reactor development in the State of São Paulo, Brazil, are considered. Emphasis is given to the estimates of expenditures in foreign currency and the generated kWh cost. Reactor types are compared, and results are presented. 22 references. (auth)

3991 (NP-18054) FLUID FLOW MEASUREMENTS INSIDE THE REACTOR-VESSEL OF THE 50-MWe DODEWAARD NUCLEAR POWER PLANT BY CROSS-CORRELATION OF THERMOCOUPLE SIGNALS. Termaat, K. P. (Gemeenschappelijke Kernenergiecentrale Nederland N. V., Arnhem). [nd]. 21p. Dep. CFSTI (U. S. Sales Only).

In the downcomer region of the reactor system of the 50 MW(e) Dodewaard Boiling Water Reactor with natural circulation, 30 pairs of fast response thermocouples are used to detect temperature fluctuations in the recirculating reactor water. After amplification and filtering, the signals of each thermocouple pair are fed into a multipoint polarity coincidence correlator to form the cross correlation function. From this function the mean transit time of the temperature fluctuations to cover the mutual distance between the thermocouples is easily found. Then the local velocity is derived. The applied method has proven to be very useful in the determination of local fluid velocities from which velocity profiles and total recirculation flow can be derived. 5 references. (auth)

3992 (ORNL-NSIC-29) PROTECTION INSTRUMENTATION SYSTEMS IN LIGHT-WATER-COOLED POWER REACTOR PLANTS. O'Brien, H. G.; Walker, C. S. (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 147p. Dep. CFSTI.

The designs of four typical protection instrumentation systems for boiling- and pressurized-water power reactors are described, and resulting conclusions and recommendations are given. Current practices in protection system designs vary widely, indicating differences in design criteria, as well as the lack of commonly recognized "best ways" in design approaches for carrying out similar functions. Authoritative information on the design bases or assumptions was not available in every case. Design approaches and techniques are in transition. The design of the instrumentation systems for the engineered safety features presents a considerably more complex problem than the design of the reactor shutdown system. 43 references. (auth)

3993 (STI/PUB-194) POWER AND RESEARCH REACTORS IN MEMBER STATES. (International Atomic Energy Agency, Vienna (Austria)). Sept. 1969. 90p. IAEA $2.00. Dep.

A listing of world-wide power reactors and research reactors operating or being built is presented. Information provided includes: reactor type, reactor location, power output, and criticality date. (D.C.C.)

3994 (STI/PUB-204) DETECTION AND LOCATION OF FAILED FUEL ELEMENTS. Panel Proceedings Series. Report of a Panel, Vienna, 13-17 November 1967. (International Atomic Energy Agency, Vienna (Austria)). 1968. 250p. (In Several Languages). (CONF-671119). IAEA $6.00.

Fuel element failure detection and location systems for power and research reactors are reviewed. Development and testing programs are described. Separate abstracts are included for 9 of the 10 papers presented. One paper has been previously abstracted and appears in NSA Vol. 22: 9984. (D.C.C.)

For abstracts of individual papers see: 4013-4019, 4102, and 4103.

3995 (TID-25242) ARDENNES NUCLEAR POWER PLANT. Quarterly Report No. 27, January 1-March 31, 1969. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). Apr. 20, 1968. 9p. Dep. CFSTI.

Activities are reported on the SENA power reactor inspection and maintenance, fuel and personnel status, and operations summary. Significant progress was made in the assembly of two reactor core hoops, external inspection of fuel assemblies and control rods, and removal of the thermal shield. (H.D.R.)

3996 (TID-25254) OPERATING HISTORY OF U. S. NUCLEAR POWER REACTORS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). 1968. 86p. Dep. CFSTI.

The information which is presented highlights the operating history of U. S. nuclear power plants through December 31, 1968. Included are those nuclear reactor facilities which produce (or have produced) electricity, even if in token amounts, or which are part of a development program concerned with the generation of a nuclear reactor as a heat source. The information presented herein is based on data furnished by facility operators. The charts are plotted in terms of cumulative thermal energy as a function of time. Since only those shutdowns of five days or more are shown, the charts do not give a detailed history of plant operation. They do, however, give the reader an over view of the operating history of a wide variety of developmental and experimental nuclear power reactors. The data presented in the tables show the yearly gross generation of electricity for each U. S. nuclear plant and, for civilian power plants, information on reactor availability and plant capacity factor. (auth)

3997 (TID-25266) ARDENNES NUCLEAR POWER PLANT. Quarterly Report No. 28, April 1-June 30, 1969. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 10 Sep 1969. 9p. Dep. CFSTI.

Operations and maintenance requirements during April 1 to June 30, 1969, are described. Design modifications are presented. (D.C.C.)

3998 (WCAP-3385-20) SAXTON PLUTONIUM PROGRAM. Semi-Annual Progress Report for the Period Ending June 30, 1969. Smalley, W. R. (Westinghouse Electric Corp., Pittsburgh,

Pa. Nuclear Fuel Div.). Oct. 1969. Contract AT(30-1)-3385. 118p. Dep. CFSTI.

NEUTRONS — effects on physical properties of Saxton Power Reactor Core 2 Zircaloy 4 clad plutonium oxide (PuO_2)–uranium oxide (UO_2) fuel elements
PLUTONIUM OXIDES PuO_2 — PuO_2–UO_2, radiation effects on physical properties of Saxton Power Reactor Core 2 Zircaloy 4 clad fuel elements of, analysis of neutron
REACTIVITY — measurement of Saxton Power Reactor Core 3
REACTOR FUEL ELEMENTS — radiation effects in Saxton Power Reactor Core 2 Zircaloy 4 clad plutonium oxide (PuO_2)–uranium oxide (UO_2), neutron
— loading of Saxton Power Reactor Core 3 Zircaloy 4 clad plutonium oxide (PuO_2)–uranium oxide (UO_2), diagram for
SAXTON POWER REACTOR — fuel elements of, post irradiation examination of Core 2 Zircaloy 4 clad plutonium oxide (PuO_2)–uranium oxide (UO_2)
— fuel elements of, loading diagram for Core 3 Zircaloy 4 clad plutonium oxides (PuO_2)–uranium oxide (UO_2)
— physics measurements for Core 3
URANIUM OXIDES UO_2 — PuO_2–UO_2, radiation effects on physical properties of Saxton Power Reactor Core 2 Zircaloy 4 clad fuel elements of, analysis of neutron
ZIRCALOY-4 — radiation effects on Saxton Power Reactor Core 2 fuel element cladding of, neutron (D.C.C.)

3999 NUCLEAR POWER PLANTS AT DOEL AND TIHANGE. Brunee, Y.; Vanden Dooren, M. ACEC (Ateliers Constr. Elec. Charleroi Rev., No. 2, 9-20(1969).

The Doel and Tihange nuclear power plants, each of which will develop a power output of about 800 MW(e), already belong to the new generation of nuclear power plants through the considerable improvements made in their design. A description of the modifications adopted in the construction of the core and internal parts of the reactors in these power plants is presented. The economically favorable results to which these modifications should lead, both for the steam-generating system and for the power plant itself, are analyzed. The improvements made to the core control protective systems, the internal instrumentation of the core, the equipment of the primary loops, and of the safety loops, including the safety injection system, the spraying of the sealed enclosure and its internal ventilation are described. (auth)

4000 OUR FUTURE NUCLEAR POWER PLANTS: GOAL, DESIGN, AND ECONOMICS. Klees, P.; Mommen, E. ACEC (Ateliers Constr. Elec. Charleroi) Rev., No. 2, 21-36(1969).

From the consumption of electricity in Belgium and the resulting development of the installed capacity, it is concluded that in 1980 the total capacity of the Belgian nuclear power plants will have to rise to 4,000 MW(e). This capacity can be reached by adding to the power plants at present under construction two 1200 MW power plants composed of twin 600 MW pressurized water units. These units would be equipped with a two-loop primary circuit with a larger module than that used for the Doel reactors. The geometrical and functional characteristics of the primary equipment and of the core are quoted. The turbo-alternator set, a new type of safety enclosure and the arrangements of the buildings are described. A brief survey of the economics of the new power plants which have been planned is included. 19 references. (auth)

4001 TRANSIENT ANALYSIS OF THE LINGEN NUCLEAR POWER STATION. Reinhardt, A. (AEG-Telefunken, Frankfurt am Main). Atomkernenergie, 14: 387-93(Nov.- Dec. 1969). (In German).

The results are presented of an extensive transient analysis which had to be carried out for testing the control systems and for demonstrating the safe control of all operating conditions as well as the insensitivity of the plant to a large number of credible accidents. Reasons are supplied for selecting this conception in which the control system is not designed for the initial base load operation, but for peak load service of the plant which will eventually come in the course of the estimated life of 40 years. 6 references. (auth)

4002 INTERNAL STRUCTURES OF THE REACTOR IN THE ARDENNES NUCLEAR POWER PLANT. Evenepoel, R.; Fabris, M.; Samson, J.-P.; Simon, A. ACEC (Ateliers Constr. Elec. Charleroi) Rev., No. 2, 3-8(1969).

The internal structures of the reactor in the SENA Power Plant are described, together with the different categories of stress to which these parts are subjected. Vibratory stresses of hydrodynamic origin were the cause of the faults which arose in the SENA reactor. The repairs made to the SENA reactor are briefly described. The design of the internal structures of the new reactors excludes the reoccurrence of the fault in new units such as those at Doel and Tihange. (auth)

4003 NUCLEAR ENERGY DEVELOPMENT IN U.S.S.R. Mabilleau. Energ. Nucl. (Paris), 11: 340-4(Aug.-Sept. 1969). (In French).

Power reactor development in the U.S.S.R. is reviewed. Pressurized-water reactors are described. (D.D.C.)

4004 REPROCESSING OF THE ELK RIVER REACTOR FUEL IN THE ITREC PLANT. Schafer, A. C. (Nuclear Associates International Corp., Rockville, Md.). Reactor Fuel-Process. Technol., 12: 259-63(Summer 1969).

The history, design, and reprocessing and refabrication processes of the ITREC plant in southern Italy are briefly described. Experience with the initial receipt of Elk River Reactor fuel at the plant and plans for hot startup operations are discussed. (H.D.R.)

4005 BONUS TO BE DISMANTLED. Skovholt, Donald J. (Atomic Energy Commission, Washington, D. C.). Reactor Fuel-Process. Technol., 12: 293-5(Summer 1969).

The proposed decommissioning plan for the Boiling Water Nuclear Superheater reactor is reviewed. It is concluded that the facility dismantling and entombment or disposal of its radioactive components will not endanger the health and safety of the public. (H.D.R.)

4006 PRESTRESSED CONCRETE CONTAINMENT VESSEL FOR GINNA NUCLEAR PLANT. Croneberger, Don K. (Gilbert Associates, Inc., Reading, Pa.). Civil Eng. (N. Y.), 39: No. 7, 52-5(July 1969).

A general description of the design concepts used for the Ginna reactor containment vessel is presented. The vessel employs concepts such as prestressing in the vertical direction, prestressed rock anchors, and a hinge connection at the base-to-cylinder discontinuity. (H.D.R.)

4007 REPAIR OF STEAM GENERATOR TUBE BUNDLES IN MARCOULE. Leboulanger, M. Genie Civil, 145: 486-95 (Aug.-Sept. 1968). (In French).

In the summer and autumn of 1966, leaks were discovered in the sleeves connecting the tube bundles to the steam collectors in the G2 and G3 reactor steam generators. The general configuration of the tube bundles and the methods used to inspect them are briefly described. Procedures followed in planning, preparation, and execution of the repair effort are detailed. (H.D.R.)

4008 DAMAGE IN NUCLEAR POWER PLANTS: AN ANALYSIS. Feldmann, J. (Allianz Versicherungs-AG., Munich). Atomwirt., Atomtech., 14: 446-8(Sept.-Oct. 1969). (In German).

Failure data on components and systems of 43 nuclear power plants are analyzed. The plants surveyed included 16 light water reactors, 6 heavy water reactors, 16 gas cooled reactors, and 5 sodium cooled reactors. Failures resulting in repair costs of more than $10,000 or a plant down-time of over 4 days are tabulated for fuel elements, control rods, pressure vessels, heat exchangers, pumps, blowers, and conventional power plant components. (H.D.R.)

4009 TROSA NUCLEAR POWER PLANT. Tek. Tidskr., 99: 117-20(1969). (In Swedish).

A review is made of the siting alternatives for a 3000 MW nuclear power plant in the neighborhood of the town of Trosa at the Baltic. (Sweden)

4010 PRESSURIZED WATER REACTOR CONTAINMENT DESIGNS. van Amerongen, Leo (Westinghouse Electric International Co., New York). Atompraxis, 15: 309-11(Sept.-Oct. 1969).

A review of the types of containment used for PWR nuclear steam supply systems is presented. The effect that containment has on the project schedule, plant layout and plant erection is discussed. (auth)

4011 STATISTICAL CONSIDERATIONS ON THE USE OF NUCLEAR POWER PLANTS. Maccazzola, Franco. Com. Naz. Energ. Nucl., Notiz., 15: No. 8-9, 55-72(Aug.-Sept. 1969). (In Italian).

The performances of nuclear power plants now in operation are compared through analysis of their power output, utilization factor, and availability of service. (auth)

4012 NUCLEAR POWER IN A BILLION DOLLAR STALEMATE. Owens, Ken (ed.). Elec. Light Power (Boston); 47: No. 4, 55-62(Apr 1969).

Licensing procedures for nuclear power plants in the U. S. are reviewed. Recommended time-saving procedures are described. (D.C.C.)

4013 FAILED FUEL ELEMENT DETECTION AND LOCATION. Briggs, D. S. (International Atomic Energy Agency, Vienna). pp 19-25 of Detection and Location of Failed Fuel Elements. Vienna, International Atomic Energy Agency, 1968.

From Conference on Failed Fuel Element Detection, Vienna, Austria. See STI/PUB-204; CONF-671119.

The various methods for detecting and locating failed fuel elements are described. The way in which the reactor design may influence the choice of a detection and location system is analyzed. 27 references. (auth)

4014 METHODS OF MONITORING THE INTEGRITY OF THE FUEL ELEMENTS OF THE CZECHOSLOVAK HEAVY-WATER REACTOR. Melikhar, Z.; Gladki, E. (Scientific Research Inst. of Energetics, Prague). pp 45-50 of Detection and Location of Failed Fuel Elements. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From Conference on Failed Fuel Element Detection, Vienna, Austria. See STI/PUB-204; CONF-671119.

The problems involved in devising a system for detecting failed fuel elements in CO_2-cooled heavy-water reactors in Czechoslovakia are described. The main parameters for reactors of this type are analyzed from the point of view of choosing a method of detecting failed fuel elements. The principles of a filtration method used to detect failures in the first nuclear power plant (A-1) are presented. The criteria which will have to be applied in choosing and developing a system for detecting failed fuel elements in later power plants are analyzed. 8 references. (auth)

4015 EXPERIENCE WITH FRENCH SYSTEMS OF FAILED FUEL ELEMENT DETECTION. pp 51-79 of Detection and Location of Failed Fuel Elements. Vienna, International Atomic Energy Agency, 1968. (In French).

From Conference on Failed Fuel Element Detection, Vienna, Austria. See STI/PUB-204; CONF-671119.

The failed fuel element detection system for the OSIRIS reactor is described. The theoretical calculations were confirmed by calibration with a uranium surface placed inside the core. The system makes use of the delayed neutron method. The EL4 reactor, which is cooled by carbon dioxide at pressures below 60 bars, has a failed fuel element detection system based on electrical precipitation of the daughter products of the fission gases. The initial results obtained during the power rise are given. A test program is being carried out in the PEGASE reactor, using elements with calibrated leakage rates. Results obtained during one of the tests in this program are discussed. Giving the main characteristics of the failed fuel element detection systems in the Chinon Power Station, failures in the three reactors since start-up are discussed by classifying them according to rate of development. Photographs show a typical burst detected during a power transient. (auth)

4016 FAILED FUEL ELEMENT DETECTION AND LOCATION IN POWER REACTORS IN JAPAN. Mochizuki, K. (Japan Atomic Energy Research Inst., Tokyo); Ikeda, T. pp 129-65 of Detection and Location of Failed Fuel Elements. Vienna, International Atomic Energy Agency, 1968.

From Conference on Failed Fuel Element Detection, Vienna, Austria. See STI/PUB-204; CONF-671119.

There are at present two power reactors in operation in Japan. Experience in failed fuel element detection and location is described for these and other reactors. The Japan Power Demonstration Reactor has no special installed detection and location systems so the following series of five tests have been devised for this purpose: neutron flux tilting test, fuel channel water sampling test, isolation can test in the spent-fuel pool, visual inspection in the spent-fuel pool, and hot laboratory tests. So far three fuel failures have been located by this method. The Tokai Nuclear Power Station has a burst cartridge detection system. Two tests were carried out using this system, namely: the pressure-step test during commissioning, and the blower cycling test at the first refueling. No fuel failures were detected during the course of these tests, subsequently however, one fuel failure was located by the BCDG. JRR-3 (a research reactor) has an elaborate failed fuel detection and location system which is now not in service. 12 references. (auth)

4017 IN-LINE CALIBRATION OF FAILED FUEL ELEMENT DETECTION SYSTEMS. Strindehag, O. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 167-74 of Detection and Location of Failed Fuel Elements. Vienna, International Atomic Energy Agency, 1968.

From Conference on Failed Fuel Element Detection, Vienna, Austria. See STI/PUB-204; CONF-671119.

Some methods of calibrating failed fuel element detection systems for water-cooled reactors are discussed. Results from several calibrations carried out in the Ågesta and R2 reactors by means of zirconium-uranium foils are presented. The specification of the sensitivity of a detection system is also treated. 8 references. (auth)

4018 BURST CARTRIDGE DETECTION IN U.K. POWER REACTORS. Cartwright, D. K. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 175-212 of Detection and Location of Failed Fuel Elements. Vienna, International Atomic Energy Agency, 1968.

From Conference on Failed Fuel Element Detection, Vienna, Austria. See STI/PUB-204; CONF-671119.

The detection and location of failed fuel elements in gas-cooled reactors in the United Kingdom relies on the wire precipitator technique in which gaseous fission products are collected on a charged wire and their daughter activities measured. A brief description of the systems installed in United Kingdom Magnox reactors and the Windscale AGR is given together with a discussion of factors affecting system performance and the ways in which operating procedures are used to aid detection. Operational experience with these systems is also discussed, and an indication of costs given. Mention is also made of techniques applicable to the SGHWR and fast reactors. 32 references. (auth)

4019 FAILED FUEL ELEMENT DETECTION AND LOCATION IN U.S. REACTORS. Ceja, S. N. (Atomic Energy Commission, Washington, D. C.). pp 213-38 of Detection and Location of Failed Fuel Elements. Vienna, International Atomic Energy Agency, 1968.

From Conference on Failed Fuel Element Detection, Vienna, Austria. See STI/PUB-204; CONF-671119.

Failed fuel element detection and location systems and techniques used with U. S. light-water reactors, sodium-cooled fast reactors, a heavy-water moderated and cooled pressure-tube reactor and a heavy-water cooled and moderated pressurized-vessel reactor are described. With regard to the light-water moderated and cooled-uranium oxide fueled power reactors, experience has shown that expensive cumbersome location systems are not necessary for satisfactory operation. In the event of fission-product detection by the light-water reactor coolant and off-gas monitoring systems the core area containing the defected fuel is determined using flux tilting techniques. The individual elements in this area are then isolated in an air or water medium. This medium is then sampled for fission products "sipped," thus identifying the defected element. The two systems used to detect fission products in Na-cooled fast reactors are the charged wire detector and a delayed-neutron monitor. The charged wire detector monitors the reactor cover gas (argon) and uses a precipitation system to collect the fission-product daughters which are then detected by a scintillation detector. The delayed-neutron monitor continuously samples the Na coolant. The Na is passed through a graphite stack containing neutron detectors to detect the moderated delayed neutrons. 19 references. (auth)

4020 CONSTRUCTION DECISION FOR THE BIBLIS NUCLEAR POWER PLANT. Mandel, H. (Vorstandsmitglied der Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). Atomwirt., Atomtech., 14: 453-5(Sept.-Oct. 1969). (In German).

The future development in the field of electricity production by nuclear power in Germany is projected. Some pilot plants are in operation and a true commercial power station is under construction at Biblis. Some of the design characteristics of the Siemens pressurized water reactor are: power, 1200 MW(e); fuel, 2.58% enriched U; total U, 99.2 tons; steam production for turbine, 6,540 tons/hr; cooling water, 200,000 tons/hr. In comparison, costs of an oil- or coal-fired power plant are approximately 30% to 60% higher, respectively. (H.B.G.)

4021 THE 1200 MW BIBLIS NUCLEAR POWER PLANT. Frewer, H. (Vorstandsmitglied der Kraftwerk Union AG., Erlangen, Ger.); Keller, W. Atomwirt., Atomtech., 14: 455-64 (Sept.-Oct. 1969). (In German).

Site selection and overall engineering design for the Biblis nuclear power station are presented. Characteristics of the plant are tabulated. Arrangement of fuel elements and control rods is discussed. Procedures are described for inspection of fuel elements during operation, change of fuel elements, the construction of the pressure vessel, and for steam production. The effects of various load factors on the power plant, especially on the reactor core, are analyzed and presented by diagrams. Safety procedures,

properties of the steam turbine, and the electricity generating system are discussed. (H.B.G.)

4022 NUCLEAR DIFFICULTIES WILL BE SURMOUNTED. Hosmer, Craig. Elec. World: 171: No. 15, 81-5(14 Apr 1969).

Problems related to the construction and operation of nuclear power plants in the U. S. are reviewed. Suggestions for anticipating delays in reactor development are presented. (D.C.C.)

Power Reactor Development

Refer also to abstracts 2091, 2092, 4113, and 4114.

4023 (ANL-7618) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, SEPTEMBER 1969. (Argonne National Lab., Ill.). Oct. 27, 1969. Contract W-31-109-eng-38. 141p. Dep. CFSTI.

Highlights of project activities are summarized for the month of September 1969. Fuel and components development programs for the LMFBR are described. LMFBR physics measurements and ZPR-3, ZPR-6, ZPR-9, and ZPPR operations during September are reviewed. Research and development programs in the EBR-2 are described. Nuclear safety studies, including TREAT operations, and chemical separation activities are discussed. (D.C.C.)

4024 (BAW-1328(Vol.2)) 1000-MWe LMFBR FOLLOW-ON STUDY. TASK II AND III FINAL REPORT. VOLUME 2. CONCEPTUAL SYSTEM DESIGN DESCRIPTIONS (SECTIONS 1-7). (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Mar. 1969. Contract 31-109-38-1998. 556p. Dep. CFSTI.

For Argonne National Lab., Ill.

Conceptual design parameters for a 1000 MW(e) LMFBR are presented. Systems described include: land and structures; reactor vessel; shielding; core; control elements and drive circuits; cooling system; and auxiliary and maintenance equipment. (D.C.C.)

4025 (DUN-SA-124) DESCRIPTION AND USES OF A CRITICAL SYSTEMS DATA FILE FOR NUCLEAR PLANTS. Greger, G. E.; Snyder, D. A.; Gross, P. D. (Douglas United Nuclear, Inc., Richland, Wash.). Oct. 1, 1969. Contract AT(45-1)-1857. 24p. Dep. CFSTI.

A Critical Systems Data File is described which was developed as an integral part of an overall maintenance program for a research installation. The Data File provides computerized recording, auditing and retrieval of test and inspection data to facilitate maintaining and improving the reliability of equipment vital to the operation of nuclear plants. (auth)

4026 (GA-9660) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending August 31, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 25, 1969. Contract AT(04-3)-167. 110p. Dep. CFSTI.

BLOWERS—design parameters of conceptual 1000 MW(e) high temperature helium cooled reactor
CRUSHING—methods and procedures for irradiated reactor fuels, comparison of
FISSION PRODUCTS—diffusion in helium filled graphite cylinder of, measurement of strontium-85
GRAPHITE—radiation effects on physical properties of boronated and hafniated, measurements of fast neutron
HEAT TRANSFER SYSTEMS—performance of conceptual 1000 MW(e) helium cooled reactor
NEUTRONS, FAST—effects on fission product release in BISO and TRISO coated uranium carbide (UC_2) sphere shaped fuel
—effects on physical properties of boronated and hafniated graphite
REACTOR CONTROL SYSTEMS—design of conceptual 1000 MW(e) high temperature helium cooled
REACTOR FUEL ELEMENTS—radiation effects on fission product release in BISO and TRISO coated uranium carbide (UC_2) sphere shaped, measurement of fast neutron
REACTOR FUELS—reprocessing methods for high temperature gas cooled power reactor, analysis of optimum economic
REACTORS, GAS-COOLED—blowers for conceptual 1000 MW(e) high temperature, design parameters of helium
—control system for conceptual 1000 MW(e) high temperature, description of
—cooling system for conceptual 1000 MW(e) high temperature, performance of
—fuel recycle for high temperature power, analysis of optimum economic reprocessing methods of
—design parameters for conceptual high temperature gas cooled, development during June to August 1969
—reactivity of high temperature power, effects of plutonium fuel on
REACTORS, POWER—blowers for conceptual 1000 MW(e) helium cooled, design parameters of helium
—control system for conceptual 1000 MW(e) helium cooled, description of
—cooling system for conceptual 1000 MW(e) helium cooled, performance of
—fuel recycle for high temperature gas cooled, analysis of optimum economic reprocessing methods of
—design parameters for conceptual high temperature gas cooled, development during June to August 1969
—reactivity of high temperature power, effects of plutonium fuel on
STRONTIUM ISOTOPES Sr-85—diffusion in helium filled graphite cylinder, measurement of
THORIUM OXIDES ThO_2—ThO_2-UO_2, oxidation of BISO coated sphere shaped
URANIUM OXIDES UO_2—ThO_2-UO_2, oxidation of BISO coated sphere shaped (D.C.C.)

4027 LIQUID-MODERATED, LIQUID-COOLED NUCLEAR REACTOR. Thome, Paul (to Commissariat a l'Energie Atomique). British Patent 1,159,379. July 23, 1969. Priority date May 18, 1967, France.

REACTORS, HEAVY WATER MODERATED—design of heavy water cooled, with flexible steam chamber connected to moderator tank (H.D.R.)

4028 PRESENT AND FUTURE DEVELOPMENTS IN FAST REACTOR TECHNOLOGY. Kronberger, H.; Smith, R. D. (United Kingdom Atomic Energy Authority, Risley, Eng.). Elec. Rev., 185: 492-6(Oct. 1969).

Advantages of fast reactors are discussed. Consideration is given to choice of coolant, design of coolant circuits, fuel and fuel assemblies, influence of Doppler coefficient on safety. The state of development, or operation, of existing reactors including the PFR, is summarized. Economic predictions suggest that large scale world development will be after 1980. (UK)

4029 INVESTIGATIONS OF LONG-TERM OPTIMUM REACTOR STRATEGIES CONSIDERING THE LIMITED EXTENT OF URANIUM RESOURCES. PART 2. RESULTS OF MODEL CALCULATIONS. Finnemann, H.; Gutgesell, W.; Maerkl, H. (Siemens AG, Erlangen, Ger.). Nukleonik, 12: 263-9(Oct. 1969).

The calculation model derived in Part 1, based on economic criteria, for investigating the problem of long-term, optimum use of different types of power stations is applied to the USA economy. The results are explained and analyzed in detail. (auth)

4030 BREEDER REACTOR NUCLEAR POWER PLANT. Gilly, L. ACEC (Ateliers Constr. Elec. Charleroi) Rev., No. 2, 37-42(1969).

The problems inherent to fast reactors are described. The construction of the core is examined in detail. The problems of mechanical strength, the control and safety of the core, and considerations on the optimum conditions for the economic use of breeder type steam-raising reactors are analyzed. (auth)

4031 REACTOR AND FUEL -PROCESSING TECHNOLOGY. VOLUME 12, NUMBER 3. One of the Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Washington, D. C., Atomic Energy Commission, Summer 1969. 59p. GPO $0.70.

Included are 5 articles concerning current developments in power reactor operating experience and components and systems development. The ITREC fuel reprocessing plant is briefly described. A separate abstract was prepared for each of the articles. (H.D.R.)

For abstracts of individual sections see: 4004, 4005, 4055, 4069, and 4070.

4032 BRITISH FAST REACTORS: A BRIEF ACCOUNT OF THE DEVELOPMENT OF LIQUID METAL-COOLED FAST REACTORS IN THE UNITED KINGDOM. Risley, Eng., United Kingdom Atomic Energy Authority, Reactor Group, [1969]. 18p.

Important aspects of the development of the fast reactor including basic physics, sodium technology, flow evaluation, component development, optimization and safety, are outlined. Fuel development is discussed. An illustrated description and main parameters of PFR are given. A brief indication is given of the fast reactor work carried on at the various UKAEA research and development establishments. (UK)

4033 THE STEAM GENERATING HEAVY WATER REACTOR NUCLEAR POWER PLANT: TECHNICAL DESCRIPTION. Risley, Eng., United Kingdom Atomic Energy Authority, Reactor Group, July 1969. 37p.

A brief sketch of the SGHWR concept is followed by an outline description of a typical plant, with main parameter tabulated for 300 MW, 400 MW and 500 MW plants. Operation and control is briefly described. Reference is made to safety and siting. Minimum staffing requirements for operation of a complete plant are quoted. A typical plant is illustrated in detail by 20 folding diagrams. (UK)

4034 EUROPEAN COOPERATION FOR THE DEVELOPMENT OF SODIUM COOLED FAST BREEDERS. Ernst, R. (Siemens AG, Erlangen, Ger.); Guthmann, E. Atomwirt., Atomtech., 14: 448-50(Sept.-Oct. 1969). (In German).

The background of cooperation between Germany, Belgium, the Netherlands, and Luxembourg on a project to design and construct a prototype 300 MW(e) sodium cooled fast breeder reactor is presented. The nuclear research organizations and industrial groups involved in the project are listed, and the status of development work is discussed. (H.D.R.)

4035 ENEA COMPARISON STUDY OF FAST REACTORS. Smidt, D. (Kernforschungszentrum, Karlsruhe, Ger.); Schuster, G. Atomwirt., Atomtech., 14: 410-13(Aug. 1969). (In German).

A comparative study of fast breeder reactors is presented as to sodium, gas, and steam cooling. One ENEA group studied gas cooling with helium and carbon dioxide. Properties of such reactors are evaluated and tabulated for three different types of fuel elements. The second group studied steam cooled fast breeders. A diagram of the proposed reactor is presented and various properties are tabulated. Based on economic considerations, fuel requirements, and safety factors, it was concluded that sodium-cooled reactors are the most promising, that the gas cooled concept should be continued, and that the steam-cooled concept should be discontinued. (H.B.G.)

4036 SEFOR: AN INTERNATIONAL PROJECT OF GERMAN FAST BREEDER DEVELOPMENT. Schikarski, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech., 14: 414-16(Aug. 1969). (In German).

Characteristics of the Southwest Experimental Fast Oxide Reactor that went critical in May 1969 are tabulated as to Na-cooling, fuel type, Ni reflector, power of 20 MW(t), and location at Fayetteville, Arkansas. Also tabulated are experimental studies of reactor characteristics. Safety procedures and costs are mentioned. The reactor is considered a prototype for second generation fast breeders. (H.B.G.)

Kinetics and Dynamics

Refer also to abstracts 4127 and 4149.

4037 (AD-692446) SIMULATION OF A LIQUID METAL FAST BREEDER REACTOR ON A HYBRID COMPUTER. Keller, Charles Lee (Naval Postgraduate School, Monterey, Calif.). June 1969. 85p. CFSTI.

A Liquid Metal Fast Breeder Reactor is simulated on a hybrid computer to study the transient behavior of the neutron density during a controlled reactivity input disturbance. The nonlinear partial differential equations of heat flow are reduced by a discrete space-continuous time method to ordinary nonlinear differential equations which are readily solved on the analog computer. Use is made of time multiplexing of the analog circuitry in order to reduce the number of components. An open-loop iteration process is employed to solve the closed-loop feedback system. Recently conducted research with the open-loop iteration method has demonstrated that a large number of iterations are required for convergence. An algorithm is developed which gives an improvement in the convergence rate for early values of time. For times greater than two seconds a stability problem with the converged solution was encountered and is discussed with some observations and comments. Innovations are introduced in the simulation of the neutron kinetics equations and in the handling of the nonlinear thermal properties of the uranium oxide fuel. (auth) (USGRDR)

4038 (AEEW-R-648) MEASUREMENT OF RELATIVE CONVERSION RATIO AND FAST FISSION RATIO IN LOW ENRICHMENT OXIDE LATTICES. Barnett, G. A.; Besant, C. B.; Murphy, M. F.; Taylor, W. H. (Atomic Energy Establishment, Winfrith (England)). Aug. 1969. 38p. Dep. CFSTI (U. S. Sales Only). UK 6s.

The techniques for the measurements of the modified conversion ratio and the ^{238}U and ^{235}U fission ratio in current use for water moderated lattices have been reviewed in some detail. The modified conversion ratio is defined as ^{238}U capture/^{235}U fission and has been determined relative to a thermal column measurement with a random uncertainty of better than ±0.5% in the mean of repeated observations in a particular fuel rod. Known systematic errors affecting the measurements were ±0.4% for fuels of up to 1.3% ^{235}U enrichment and ±0.7% for 3% enriched fuels. ^{238}U capture measurements were based on detecting the 106 keV γ ray in coincidence with the 104 keV x-ray which resulted from the decay of ^{239}Np. An independent check was made on the ^{239}Np formation using a chemical separation technique. Results by the two techniques are compared and agreement is good being of a similar order of magnitude to the errors in the measurements. Measurements of fissions in ^{238}U relative to fissions in ^{235}U have also been made with a random uncertainty of ±1% but to this error must be added a systematic error of up to ±3.1% resulting mainly from a calibration measurement, P(t), which relates γ activity to true fissions. As an example of the use of these techniques the results are reported from measurements made in SGHW type cores with fuels of different enrichments and in a light water moderated uniform lattice consisting of 3% enriched UO_2 fuel rods. Experimental values of fission ratios and relative conversion ratios are compared with WIMS predictions. 22 references. (auth)

4039 (AI-AEC-12857) LMFBR PHYSICS PROGRAMS ANNUAL TECHNICAL PROGRESS REPORT, GFY 1969. (Atomics International, Canoga Park, Calif.). Sept. 30, 1969. Contract AT(04-3)-701. 71p. Dep. CFSTI.

CRITICAL ASSEMBLIES—physics measurements for ECEL Cores 17, 17P, and 18, (E/T)
LIQUID METAL FAST BREEDER REACTOR—physics measurement programs during 1969
—physics measurements of, computer programs for
NEUTRONS, FAST—spectra in liquid sodium and steel, effects of shield configuration on
NEUTRONS, INTERMEDIATE—spectra in liquid sodium and steel, effects of shield configuration on
REACTIVITY—measurement of ECEL Cores 17, 17P, and 18, (E/T)
SODIUM—neutron flux spectra in, effects of shield configuration on intermediate and fast
STEEL—neutron flux spectra in, effects of shield configuration on intermediate and fast (D.C.C.)

4040 (CISE-R-116) RECENT STUDIES ON THE NUCLEAR PERFORMANCE OF NATURAL URANIUM FUELLED, D_2O MODERATED LATTICES DESIGNED FOR A FOG COOLED POWER REACTOR. Topical Report No. 9. Bonalumi, R.; Zorzoli, G. G. (Centro Informazioni Studi Esperienze, Milan (Italy)). June 1964. 34p. Dep. CFSTI (U. S. Sales Only).

The nuclear performance of some natural uranium metal fueled lattices designed for operation with light water-steam mixture cooling in a D_2O moderated power reactor is analyzed. The importance of some parameters in determining the fuel lifetime and the void coefficients is emphasized; the need for more specific experimental data is also pointed out. 16 references. (auth)

4041 (DUN-6065) SUPPLEMENTAL NOTES ON THE COMPUTER CODE ALCHEMY-II. Kupinski, A. F. (Douglas United Nuclear, Inc., Richland, Wash.). Sept. 1, 1969. Contract AT(45-1)-1857. 26p. Dep. CFSTI.

The ALCHEMY-2 computer program for the UNIVAC is described. The computer program solves the vector differential equation representation of time-dependent isotopic buildup and depletion. 4 references. (D.C.C.)

4042 (GEAP-5744) ANALYTICAL PROCEDURES AND APPLICATIONS OF FLUENCE DETERMINATIONS FROM EBR-II FLUX WIRES. Withop, A.; Hutchins, B. A.; Martin, G. C. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jan. 1969. Contract AT(04-3)-189. 26p. Dep. CFSTI.

A detailed review is presented of the General Electric methods and data used in determining flux levels in the EBR-II by use of flux-wire analysis. Comments are offered on the accuracies involved in these methods as compared to the methods employed by the Argonne National Laboratory. In addition, other measurements of fluence are analyzed. Neutron energy ranges which can be best expected to show correlations with possible damage mechanisms are discussed with suggestions as to the best means of "measuring" the neutron fluxes over the energy ranges of interest. 6 references. (auth)

4043 VARIATIONS IN NEUTRONIC CHARACTERISTICS ACCOMPANYING BURNUP IN A LARGE FAST BREEDER. Yamashita, Shizuo (Sumitomo Atomic Energy Industries, Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 6: 573-86(Oct, 1969).

Burnup calculations based on one-dimensional slab model approximation have been performed to determine the variations occurring in the neutronic characteristics of a pancake-shaped 1,000 MW(e) Na-cooled fast breeder when operated under a specified refueling scheme. The fissile plutonium enrichment [fiss. Pu/(Pu + U)] of the initially loaded fuel is 18.0%. It proves that the partial replacement of spent fuel according to the specified scheme requires use of fresh fuel containing 21.6% fissile plutonium in order to prevent the decline of reactivity with progress of refueling cycles. The above enrichment of the replacement fuel will assure equilibrium of the neutronic characteristics after about 5 years of operation. Thus, unless the refueling charges are provided with fissile plutonium enrichment higher than that of the initially loaded fuel, the state of the reactor will soon fall below criticality. When the refueling cycle is repeated with fuel of the above specified enrichment, the breeding ratio will decline with progress of operation, from 1.24 in the initial state to 1.14 in the equilibrium state. At the same time, both Na void effect and Doppler coefficient will tend toward more unfavorable values, the former from $-0.083\ \Delta k/k\%$ to $+0.68\ \Delta k/k\%$ (calculated for cases of complete Na removal from core), and the latter from $-0.0075T \cdot dk/dT$ to $-0.0051T \cdot dk/dT$ (with Na). Thus, reactor safety is foreseen to be gradually encroached as the operation progresses. 9 references. (auth)

Control Systems

4044 REVIEW OF NUCLEAR INSTRUMENTATION FOR FAST REACTORS. Kawaguchi, Chiyoji. Nippon Genshiryoku Gakkaishi, 11: 618-25(1969). (In Japanese).

Neutron detectors in fast reactors that operate in an environment of high temperature and high γ-ray level are reviewed. A number of solutions have been tried so far. The classical method is detector cooling and shielding, but this has the drawback of high cost and is unreliable and detrimental to reactor safety. A much better alternative is the high speed counting system, which can extend 1.5 to 2 decades of counting, and the intermediate range can be measured by log-count-rate method to cover 6 to 7 decades. The Campbell method is also considered helpful in avoiding the effect of γ-rays, but its measuring range is not as wide as might be expected due to α-rays from the natural decay of ^{235}U. High temperature neutron detectors have been developed in the United Kingdom and the United States. They are available for 550 to 650°C. The choice of signal cables and connectors is important, and these components still call for further development to withstand severe service conditions. The review also gives actual examples of nuclear instrumentation and the trends of development in the United States. (auth)

4045 LIQUID MODERATED NUCLEAR REACTORS. Wray, Dudley (to United Kingdom Atomic Energy Authority). British Patent 1,167,506. Oct. 15, 1969. Filed Oct. 28, 1966.

Reference is made to reactivity control of liquid moderated reactors. In large reactors of this type local variations of reactivity can occur in the core. Spatial control methods for reactivity by moderator level control are described. The moderator mass is divided into interconnected sections, and means are provided for differentially pressurizing the free surfaces of the moderator so as to effect transfer between the sections. (UK)

Shielding

4046 PRESTRESSED CONCRETE PRESSURE VESSEL AND METHOD OF CONSTRUCTION OF SAID VESSEL. Lacroix, Roger; Magnas, Jean-Pierre (to Societe Generale d'Exploitations Industrielles). British Patent 1,159,944. July 30, 1969. Priority date Oct. 29, 1965, France.

PRESSURE VESSELS—construction of gas cooled reactor multiple layer prestressed concrete, method for
REACTORS, GAS-COOLED—pressure vessel for, construction method for multiple layer prestressed concrete (D.C.C.)

4047 NUCLEAR REACTOR INSTALLATIONS. Sidebotham, Ernest William (to United Kingdom Atomic Energy Authority). British Patent 1,166,863. Oct. 15, 1969. Filed Jan. 31, 1966.

Reference is made to nuclear power plants employing water cooled reactors and steam turbines. In such a system radioactive matter may be deposited in the turbine and its accumulation may present a hazard to personnel. The coolant pipes and turbines described are surrounded by particulate material which serves as thermal insulation and biological shielding. Also, walls defining exclusion distances are not required. The particulate material is comprised of at least one compound of Pb, Fe, Bi, Ba or depleted U. Preferred materials are iron oxide or lead based compounds such as PbO, PbS, or Pb_3O_4. These materials need not be pure, and may comprise crude or partially refined ore. The material is preferably contained in an evacuated and hermetically sealed Al envelope; the voids bounded by adjacent particles serve to increase the thermal insulation. (UK)

Cooling Systems

Refer also to abstract 2383.

4048 (APDA-227) EVALUATION OF MATERIALS WASTAGE DUE TO REACTIONS OF WATER IN SODIUM. Chamberlain, H. V.; Kanamori, A. J.; Lindsey, P. S. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 1969. Contract AT(11-1)-865. 39p. Dep. CFSTI.

A review has been made of the literature pertaining to reactions of water with Na, with particular emphasis on the factors influencing wastage of materials in such reactions. The main objective of the review was to determine if sufficient experimental data exist to develop a correlation of the various factors which affect materials wastage rates. Descriptions are given of the various test rigs used in the experimental investigations, and the various factors affecting material wastage rates are discussed. Recommendations are given for the future development of additional data in the reported area of interest. 16 references. (auth)

4049 (EURAEC-2092) STABILITY STUDIES FOR BOILING-WATER REACTORS. Final Report No. 2, April 1, 1964-June 30, 1968. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). Contracts 020-64-4-TEED(R and D); 085-66-1-TEED(R and D). 311p. (EUR-4012; AEG-E-31/E-1201). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The steady state and dynamic behavior of an electrically heated channel with two phase flow, typical for BWR's with forced flow, has been investigated for flow and power perturbations by measuring the frequency response of the local voids along the channel. The frequency response: power-local void was obtained both for constant flow and for constant channel pressure drop. Integration of the local voids led to the total void. These experimental results were compared with calculations of the AMOK-L-program, which is based on the analytical model of Kirchenmayer. The model needs as input constants which are derived from empirical slip and pressure drop correlations. Special steady state measurements provided the needed information. The overall agreement between experimental and theoretical local void response was quite satisfying, whereas the total void revealed disagreement in the high frequency region. By modification of the total void theory good agreement in both phase and amplitude could be achieved. 16 references. (auth)

4050 (ORNL-4424, pp 101-241) PRESTRESSED-CONCRETE REACTOR PRESSURE VESSEL RESEARCH AND DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

CONCRETES—creep under prestressed concrete reactor vessel operating conditions
—moisture migration in reactor grade
—strength of, effects of temperature and temperature cycling on
—failure of prestressed, acoustic emission techniques for detection of incipient
PRESSURE VESSELS—structural behavior of prestressed concrete, methods for analysis of
—failure of prestressed concrete, model tests on
—failure of prestressed concrete, acoustic emission techniques for detection of incipient
REACTORS, GAS-COOLED—pressure vessels for, development of prestressed concrete (H.D.R.)

4051 (ORNL-TM-2696) ASSESSMENT OF MOLTEN SALTS AS INTERMEDIATE COOLANTS FOR LMFBR'S. McDuffie, H. F.; McCoy, H. E.; Robertson, R. C.; Scott, Dunlap; Thoma, R. E. (Oak Ridge National Lab., Tenn.). Sept. 3, 1969. 39p. Dep. CFSTI.

Several molten salts were considered as intermediate coolants

for LMFBR's. Included were fluoride, chloride, carbonate, nitrate-nitrite and fluoroborate salts. Chemical reactions that could occur between sodium and fluoroborates lead to the conclusion that carbonates might be a better choice for LMFBRs. Use of carbonates avoids the safety considerations and related costs that arise from the reactions of sodium with water if a steam generator fails and with air if a coolant pipe ruptures. In the absence of these safety considerations, sodium is clearly superior to the molten salts as an intermediate coolant for LMFBR's because the lower thermal conductivity and higher viscosity of the salts would result in higher equipment costs. 23 references. (auth)

4052 A METHOD OF TREATING CARBON DIOXIDE GAS IN GRAPHITE-MODERATED NUCLEAR REACTORS. Dirian, Gregoire; Dolle, Lucien; Zermizoglou, Roger (to Commissariat a l'Energie Atomique). British Patent 1,158,885. July 23, 1969. Priority date Dec. 30, 1965, France.

A method is described for eliminating the impurities formed by radiolysis in the CO_2 gas coolant of graphite-moderated reactors. The CO_2, containing methane to inhibit the CO_2 reaction with graphite, is diverted from the reactor coolant stream and passed through two catalytic reaction columns. One catalyst is a conversion type (e.g., copper and zinc) and the other is a methanation catalyst (e.g., Ni, Co, or Ru). The impurities (H_2, CO, and H_2O) are reconverted to methane and CO_2 gas. (H.D.R.)

4053 IMPROVEMENTS IN REACTOR PUMPING SYSTEM. (to General Electric Co.). British Patent 1,158,550. July 16, 1969. Priority date Oct. 19, 1965, United States.

A reactor coolant recirculation system is described in which two jet pumps in series are used. The pumps have a small mass flow ratio and are feedwater driven. The feedwater stream is used to cool the recirculating water at the first pump to prevent flashing into steam at the pump inlet. The low mass flow ratio of the pumps makes them relatively insensitive to pressure changes across the reactor core, thus facilitating reactor control. (H.D.R.)

4054 IMPROVEMENTS IN AND RELATING TO PRESSURE-CONTROL DEVICES FOR POWER-WATER REACTORS. (to N. V. Philips' Gloeilampenfabrieken). British Patent 1,162,707. Aug. 27, 1969. Priority date Oct. 7, 1965, Netherlands.

HEAT TRANSFER SYSTEMS—pressure regulating device for pressurized water power reactor, description of electric heated
REACTORS, POWER—cooling system of pressurized water, description of electric heated pressure regulating device for primary
REACTORS, PRESSURIZED-WATER—cooling system of power, description of electric heated pressure regulating device for primary (D.C.C.)

4055 PUMPS FOR SODIUM-COOLED FAST BREEDER REACTORS. Allen, Robert C. Sr. (Argonne National Lab., Ill.). Reactor Fuel-Process. Technol., 12: 264-78(Summer 1969).

The development status of pumps for sodium systems is reviewed. The design and operating characteristics of the various types of sodium pumps are described, and pumps used in some existing sodium-cooled reactor systems are illustrated. Bearing and seal development for sodium pumps is discussed. 26 references. (H.D.R.)

Fuels

Refer also to abstracts 2101 and 2921.

4056 (CEA-R-3863) BURNUP DETERMINATION OF POWER REACTOR FUEL ELEMENTS BY GAMMA SPECTROMETRY. Robin, Michel; Jastrzeb, Maurice; Boisliveau, Serge; Boyer, Robert; Vidal, Rene (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Aug. 1969. 75p. (In French). Dep. CFSTI (U. S. Sales Only).

A method for determining by γ spectrometry the burnup and the specific power of fuel elements irradiated in power reactors is described. The energy spectrum of γ rays emitted by fission products is measured by means of a simple equipment using a sodium iodide detector and a multichannel analyzer. One hundred fuel elements were studied and burnup values obtained by γ spectrometry are compared to results given by chemical analyses. 7 references. (auth)

4057 (CISE-R-117) PRELIMINARY DESIGN DATA FOR THE CIRENE REACTOR POWER CHANNELS. Technical Report No. 10. Cravarolo, L.; Lombardi, C.; Mazzotti, G.; Tabacchi, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). Aug. 1965. Contract 005.63.7-NTRI. 130p. (In Italian). Dep. CFSTI (U. S. Sales Only).

Screening calculations for core configurations and preliminary mechanical design of fuel elements for the CIRENE program are given. Calculations are made for determining the critical parameters for Zircaloy-clad tubular fuel elements; axial and radial fluxes are determined and heat transfer characteristics are calculated. Parametric pressure-temperature studies for the fuel elements are described; results are shown graphically. Conceptual design parameters for the parametric studies are tabulated. Design details for metal and oxide cores are compared. 12 references. (M.L.S.)

4058 (GEAP-10028-31) SODIUM-COOLED REACTORS: FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Thirty-First Quarterly Report, May-July 1969. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Aug. 1969. Contract AT(04-3)-189. 126p. Dep. CFSTI.

FAST CERAMIC REACTOR—fuel elements for, development during May-July 1969
—core neutronics of
—thermal hydraulics of
—safety characteristics of
FISSION PRODUCTS—release from fast reactor mixed oxide fuel elements
INCOLOY 800—properties for use as fast reactor fuel cladding
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, radiation testing of fuels of
—PuO_2-UO_2, physical properties of fuels of
REACTOR FUEL ELEMENTS—development of high performance mixed oxide, for Fast Ceramic Reactor
—cladding for mixed oxide, performance of defected
—cladding interface performance in contact with sodium
—fission product distribution and release rate from mixed oxide
—cladding alloys for mixed oxide fast, performance of
—response of axially-restrained mixed oxide, during severe transients
REACTOR FUELS—relocation of molten mixed oxide, during severe transients
—performance of mixed oxide fast
REACTOR SAFETY—transient behavior of Fast Ceramic Reactor fuel
STAINLESS STEEL—properties for use as fast reactor fuel cladding
URANIUM OXIDES UO_2—PuO_2-UO_2, radiation testing of fuels of
—PuO_2-UO_2, physical properties of fuels of (H.D.R.)

4059 (ORNL-4424) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1969. Savolainen, Ann W. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 245p. Dep. CFSTI.

Activities concerning the development of gas-cooled power reactors are reported. The principal effort has been in the areas of: (1) high-temperature gas-cooled reactor fuel element development and evaluation, (2) gas-cooled fast reactor fuel irradiation testing, and (3) prestressed concrete pressure vessel development. A separate abstract was prepared for each of the three sections presented. (H.D.R.)

For abstracts of individual sections see: 4050, 4060, and 4061.

4060 (ORNL-4424, pp 3-72) HIGH-TEMPERATURE GAS-COOLED REACTOR DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

BOILERS—welds in high temperature gas cooled reactor steam generators, corrosion resistance of nickel alloy
CARBON—radiation effects on pyrolytic coatings of, fast neutron
CESIUM ISOTOPES Cs-134—deposition in high temperature gas cooled reactor coolant loops
FISSION PRODUCTS—release from high burnup coated particle fuels, effect of temperature on
—deposition in high temperature gas cooled reactor coolant loops
NEUTRONS, FAST—effects on pyrolytic carbon coatings
NICKEL ALLOYS—corrosion resistance in steam generator welds
RADIATION TARGET CANS—design of instrumented, for coated particle fuel irradiation
REACTOR FUELS—radiation effects on stability of bonded beds of coated particles

—failure of coated particles in bonded beds, at high temperatures
—fission product release from high burnup coated particles, effect of temperature on
REACTORS, GAS COOLED—fuel elements for high temperature, development and irradiation testing of
—fuels for high temperature, irradiation testing of coated particle
—steam generators for high temperature, corrosion resistance of nickel alloy welds in
THORIUM OXIDES ThO_2—radiation testing of coated particle fuels of
URANIUM CARBIDES—radiation testing of coated particle fuels of
URANIUM OXIDES UO_2—radiation testing of coated particle fuels of (H.D.R.)

4061 (ORNL-4424, pp 75-98) GAS-COOLED FAST REACTOR DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, radiation testing of gas cooled fast reactor fuels of
REACTOR FUEL ELEMENTS—performance of gas cooled fast, effects of fuel and cladding interactions on
REACTORS, FAST—fuel elements for gas cooled, irradiation testing of
REACTORS, GAS COOLED—fuel elements for fast, irradiation testing of
URANIUM OXIDES UO_2—radiation testing of gas cooled fast reactor fuels of
—PuO_2–UO_2, radiation testing of gas cooled fast reactor fuels of (H.D.R.)

4062 IMPROVEMENTS IN AND RELATING TO A NUCLEAR REACTOR FUEL ELEMENT ASSEMBLY. Peyrot, Jean-Pierre; Thome, Paul (to Commissariat a l'Energie Atomique). British Patent 1,162,578. Aug. 27, 1969. Priority date Aug. 12, 1966, France.

REACTOR FUEL ELEMENTS—assemblies of parallel pencil type, description of spigot ring supported tie-rod spaced
REACTORS, GAS-COOLED—fuel assemblies for, description of spigot ring supported parallel tie-rod spaced pencil type (D.C.C.)

4063 CALCULATION OF POWER OF HIGHLY ENRICHED STEAM-COOLED FUEL RODS IN THE KAHL BOILING WATER REACTOR. Huebner, A. (AEG-Telefunken, Frankfurt am Main). Atomkernenergie, 14: 397-400 (Nov.-Dec. 1969).

In July 1967 four highly enriched steam-cooled fuel rods, which are being developed for the steam-cooled fast reactor (DSR), were introduced into the experimental loop of the Kahl boiling water reactor. The power of the experimental rods was determined by the calculation methods commonly used for boiling water reactors. Good agreement has been achieved between theory and experiment. 8 references. (auth)

4064 RELEASE OF FISSION GASES FROM FUEL ELEMENTS IN WATERCOOLED REACTORS. Boeck, H.; Fleck, C. M. (Atominstitut, Vienna). Atomkernenergie, 14: 394-6 (Nov.-Dec. 1969). (In German).

A system has been developed which permits identification of small fuel element cladding failures by the release of fission gases. Water of the primary water circuitry of the Triga reactor is degassed and the gases are counted and identified in a low level proportional counter. By this method ^{85}Kr and ^{133}Xe have been found. The fuel elements of the Triga Mark II have been checked this way and two fuel elements with abnormal fission gas release have been detected. 13 references. (auth)

4065 IMPROVEMENTS IN HEAT EXCHANGE ELEMENTS. Boorman, Colin; Betts, Colin (to United Kingdom Atomic Energy Authority). British Patent 1,167,503. Oct. 15, 1969. Filed Nov. 23, 1965.

Reference is made to means for improving heat transfer from cluster type reactor fuel elements to liquid metal coolants by suitable shaping of the transverse spacer grids. A simple but very effective form of deflector is provided on the grids. The latter are in for form of thin strips defining cells for the fuel pins, and one edge of the strips is irregular in shape so as to promote eddy diffusion in the coolant passing through the grid. The irregular edge is created by cutting along the width of the strips and deflecting adjacent cut portions in opposite directions. The grid may be constructed with individual cells joined together by bent strip material contacting an adjacent strip at crests and troughs. The cells may be hexagonal. (UK)

4066 NUCLEAR FUEL ASSEMBLY. (to Societe Belge Pour l'Industrie Nucleaire S. A. Belgonucleaire). British Patent 1,169,868. 5 Nov 1969. Priority date 7 Sep 1967, Belgium.

REACTOR FUEL ELEMENTS—design with coolant flow-twisters between longitudinal bundle subdivisions
REACTORS, POWER—fuel elements for, coolant flow-twisters for uniform cooling of (H.D.R.)

Auxiliary and Emergency Systems

4067 (CONF-691102-1) A VERTICAL ASSEMBLER-DISMANTLER FOR THE FUEL CYCLE FACILITY. EBR-II Project. Sales, W. L.; Mitchell, D. L.; White, J. R.; Simon, J. P. (Argonne National Lab., Idaho Falls, Idaho). [1969]. Contract W-31-109-eng-38. 21p. Dep. CFSTI.

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

A change in the program of Experimental Breeder Reactor (EBR-II) from a power demonstration reactor to a fast-flux irradiation facility necessitated a corresponding change in the capabilities of the adjoining Fuel Cycle Facility for handling irradiated subassemblies. A new Vertical Assembler-Dismantler (VAD) capable of handling experimental capsules was designed, constructed, and installed in the FCF Air Cell to replace existing driver-fuel assembly and disassembly equipment. This new machine was remotely installed with a minimum of interruption of normal cell activities. Performance of the new machine has met all design requirements adequately. 8 references. (auth)

4068 (IN-1325) SIMULATED DESIGN BASIS ACCIDENT TESTS OF THE CAROLINAS VIRGINIA TUBE REACTOR CONTAINMENT: PRELIMINARY RESULTS. Norberg, J. A.; Bingham, G. E.; Schmitt, R. C.; Waddoups, D. A. (Idaho Nuclear Corp., Idaho Falls). Oct. 1969. Contract AT(10-1)-1230. 58p. Dep. CFSTI.

Simulated design basis accident (DBA) tests were performed on the containment system of the recently decommissioned Carolinas Virginia Tube Reactor (CVTR). Preliminary data of the pressure-temperature response of the containment system to the simulated DBA conditions are presented and compared to analytical predictions of the containment response. The pressure reduction sprays were demonstrated to be effective in reducing the containment pressure. 9 references. (auth)

Operation and Economics

Refer also to abstracts 3996, 4110–4112, and 4115.

4069 CURRENT PRACTICES IN REFUELING LIGHT- AND HEAVY-WATER POWER REACTORS. Steigelmann, William H. (Franklin Inst. Research Labs., Philadelphia). Reactor Fuel-Process. Technol., 12: 243-58 (Summer 1969).

Procedures and equipment used to provide a safe and effective means of moving, handling, and storing nuclear fuel from the time it reaches the reactor site until it is shipped off-site for reprocessing or disposal are reviewed. The power reactor types considered are either boiling or pressurized light-water-moderated and heavy-water-moderated with either heavy water or light water coolant. (H.D.R.)

4070 SODIUM-COOLED REACTORS: HIGHLIGHTS OF OPERATING EXPERIENCE IN PLANT SYSTEMS. Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Fuel-Process. Technol., 12: 279-92 (Summer 11969).

Experience in the operation of sodium systems is summarized for the period January 1966 to January 1969. Emphasis is placed on component or systems malfunction in the EBR-II, Fermi Fast Breeder, Dounreay Fast Reactor, Rapsodie, and BR-5. Problems caused by these failures are described, and probable failure causes and corrections are discussed. 36 references. (H.D.R.)

Safety and Siting

Refer also to abstract 2292.

4071 (AI-AEC-12858) LMFBR SAFETY PROGRAMS. Annual Technical Progress Report, GFY 1969. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. 42p. Dep. CFSTI.

LIQUID METAL FAST BREEDER REACTOR—safety program during 1969
—accidents in, analysis of uranium oxide (UO_2) aerosol production and liquid sodium combustion during
REACTOR SAFETY—accidents in LMFBR, analysis of uranium oxide (UO_2) aerosol production and liquid sodium combustion during
SODIUM—combustion of sprays of liquid, physics measurements for Spray Test Vessel, (E/T)
URANIUM OXIDES UO_2—aerosols of, effects of LMFBR accident conditions on distribution and production of (D.C.C.)

4072 (BNL-14070) ON THE BEHAVIOR OF AEROSOLS UNDER FAST REACTOR ACCIDENT CONDITIONS. Castleman, A. W. Jr.; Horn, F. L.; Lindauer, G. C. (Brookhaven National Lab., Upton, N. Y.). Sept. 1969. 18p. (CONF-691104-1). Dep. CFSTI.

From International Congress on the Diffusion of Fission Products, Saclay, France.

The results of both theoretical and experimental studies of the characteristics of PuO_2 and UO_2 aerosols are presented. A computer program was developed to calculate the time dependence of the aerosol behavior taking into account relationships for thermal, sedimentation, and turbulent coagulation, and particle deposition. The results of a parametric study are presented which show that the variation with time of aerosol mass concentration is strongly dependent on the initial concentration value and the associated initial particle size distribution. Theoretical results, in agreement with experiment, show that the average aerosol particle size increases with time, approaches a maximum, and then decreases to a nearly constant value. Experimental results are given for PuO_2 and UO_2 aerosols generated in a 1-meter high settling chamber. A comparison of these results with the calculations made employing the theoretical model shows good agreement. (auth)

4073 (ORNL-NSIC-64) ABNORMAL REACTOR OPERATING EXPERIENCES, 1966-1968. (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 92p. Dep. CFSTI.

Incidents occurring in reactor operations during 1966 to 1968 are reviewed. A description of each incident and the resulting damage to the facility is included. Corrective actions taken for each incident are also described. (D.C.C.)

4074 (ORNL-TM-2283) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT, MAY-JUNE 1968. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). July 30, 1968. Contract W-7405-eng-26. 170p. Dep. CFSTI.

AEROSOLS—removal following coolant loss accidents of stainless steel oxide-uranium oxide (UO_2), filter performance for
CARBON (SURFACE-ACTIVE)—sorptive properties for iodomethane of Witco OF-31 and OF-42
CHARCOAL—combustion of, effects of fission product decay heat on
DATA ACQUISITION SYSTEMS—operation of Nuclear Safety Information Center, during May to June 1968
FISSION PRODUCTS—release from Zircaloy clad uranium oxide (UO_2) fuel elements, effects of coolant loss conditions on
GRAPHITE—corrosion by steam, effects of steam concentration on, (E/T)
INFORMATION CENTERS—operation of Nuclear Safety, during May to June 1968
IODINE—distribution between air and water, effects of spray additives on
MEMBRANE FILTERS—effectiveness for stainless steel oxide-uranium oxide (UO_2) aerosols
METHANE, IODO-—sorption by Witco OF-31 and OF-42 surface active carbon
—distribution between air and water, effects of spray additives on
—removal by NSPP spray system, effectiveness of Runs 43 to 49 for
NUCLEAR SAFETY PILOT PLANT—removal of iodomethane during Runs 43 to 49 from
PLATES—mechanical properties of HSST steel, effects of thickness on
REACTOR CONTAINMENT SYSTEMS—pressure suppression, analysis of steamjet size and configuration in water for, (E/T)
REACTOR FUEL ELEMENTS—failure of Zircaloy clad uranium oxide (UO_2) rod type, effects of coolant loss conditions on
REACTOR SAFETY—research and development program during May to June 1968, analysis of ORNL
—standards for development of water cooled reactors
REACTORS, GAS-COOLED—graphite burnoff in high temperature, effects of steam concentration on
STEAM—corrosive effects on graphite, effects of steam concentration on, (E/T)
STEEL—tensile properties of HSST, effects of thickness on (D.C.C.)

4075 (ORNL-TM-2368) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT, JULY-AUGUST 1968. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 184p. Dep. CFSTI.

ALUMINUM ALLOYS AND SYSTEMS—corrosion by sodium borate and sodium thiosulfate aqueous solutions and sprays
CHARCOAL—combustion of, effects of fission product decay heat on
COPPER ALLOYS AND SYSTEMS—corrosion by sodium borate and sodium thiosulfate aqueous solutions and sprays
DATA ACQUISITION SYSTEMS—operation of Nuclear Safety Information Center, during July to August 1968
FISSION PRODUCTS—release from Zircaloy clad uranium oxide (UO_2) fuel elements, effects of coolant loss conditions on
—distribution of aerosol, from LOFT condition fuel element failure
—size of aerosol, effects of age, humidity, and time during LOFT conditions on
GRAPHITE—corrosion by steam, effects of steam concentration on, (E/T)
INFORMATION CENTERS—operation of Nuclear Safety, during July to August 1968
IODINE—distribution between air and water, effects of spray additives on
KRYPTON ISOTOPES—removal from air by methyl phenyl silicon rubber membranes
MEMBRANE FILTERS—effectiveness of methyl phenyl silicone rubber, for krypton removal from air
METHANE, IODO-—distribution between air and water of, effects of spray additives on
NOZZLES—stresses in multiple and single cylindrical and spherical shell connected, effects of configuration on
PLATES—mechanical properties of HSST steel, effects of thickness on
REACTOR CONTAINMENT STRUCTURES—coolant loss accident condition testing of scale model pressure suppression, test schedule and equipment design for
REACTOR CONTAINMENT SYSTEMS—aerosol distribution in, effects of coolant loss conditions on solid
REACTOR FUEL ELEMENTS—failure of Zircaloy clad uranium oxide (UO_2) rod type, effects of coolant loss conditions on
REACTOR FUEL ELEMENTS—failure of, fission product aerosol distribution under LOFT condition from
—fission product release from high temperature gas cooled, effects of temperature on
REACTOR SAFETY—research and development program during July to August 1968, analysis of ORNL
—standards for development of water cooled reactors
REACTORS, GAS-COOLED—graphite burnoff in high temperature, effects of steam concentration on, (E/T)
—fuel elements of high temperature, effects of temperature on fission product release in
SILICONE RUBBERS—membranes of methyl phenyl, efficiency for removal of krypton from air of
SODIUM BORATES—corrosive effects on aluminum and copper alloys of aqueous solutions and sprays of, (E)
SODIUM THIOSULFATES—corrosive effects on aluminum and copper alloys of aqueous solutions and sprays of, (E)
STEAM—corrosive effects on graphite, effects of steam concentration on, (E/T)
STEEL—tensile properties of plates of HSST, effects of thickness on (D.C.C.)

4076 (ORNL-TM-2425) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT, SEPTEMBER-OCTOBER 1968. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 156p. Dep. CFSTI.

AEROSOLS—removal following coolant loss accidents of stainless steel oxide-uranium oxide (UO_2), filter performance for
ALUMINUM ALLOYS AND SYSTEMS—corrosion by aqueous sodium borate and sodium thiosulfate solutions and sprays
COPPER ALLOYS AND SYSTEMS—corrosion by aqueous sodium borate and sodium thiosulfate solutions and sprays

DATA ACQUISITION SYSTEMS—operation of Nuclear Safety Information Center, during September to October 1968
GRAPHITE—corrosion by steam, effects of concentration on
INFORMATION CENTERS—operation of Nuclear Safety, during September to October 1968
KRYPTON ISOTOPES—removal from air by methyl phenyl silicon rubber membranes
MEMBRANE FILTERS—effectiveness for stainless steel oxide–uranium oxide (UO_2) aerosol
—effectiveness of methyl phenyl silicone rubber for krypton and xenon removal from air
METHANE, IODO-—distribution between air and water of, effects of spray additives on
—removal by aqueous sodium borate and sodium thiosulfate spray solutions
—sorption in pressure suppression pool type containment structure, scale model testing of
NOZZLES—stresses in multiple and single cylindrical and spherical shell connected, effects of configuration on
PLATES—mechanical properties of HSST steel, effects of flaws on
REACTOR CONTAINMENT STRUCTURES—coolant loss accident condition testing of scale model pressure suppression, analysis of methyl iodide absorption for
REACTOR FUEL ELEMENTS—failure of Zircaloy clad uranium oxide (UO_2) rod type, effects of coolant loss conditions on, (E)
—fission product release in high temperature gas cooled, effects of temperature on
—failure of carbon coated bonded bed uranium carbide particle type, effects of temperature on
REACTOR SAFETY—research and development program during September to October 1968, analysis of ORNL,
—standards for development of water cooled reactors
REACTORS, GAS-COOLED—graphite burnoff in high temperature, effects of steam concentration on
—fuel elements of high temperature, effects of temperature on fission product release in
SODIUM BORATES—corrosive effects on aluminum alloys, copper alloys, and stainless steel, of aqueous solutions and sprays of
SODIUM THIOSULFATES—corrosive effects on aluminum alloys, copper alloys, and stainless steel, of aqueous solutions and sprays of
STAINLESS STEEL—corrosion by aqueous sodium borate and sodium thiosulfate solutions and sprays of Type 304 and Type 316
STEEL—tensile properties of plates of A533 HSST, effects of flaws on
URANIUM CARBIDES—fuel elements of carbon coated, effects of temperature on failure of
XENON ISOTOPES—removal from air by methyl phenyl silicon rubber membranes (D.C.C.)

4077 (ORNL-TM-2718) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM. Bimonthly Report, July–August 1969. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Nov 1969. Contract W-7405-eng-26. 117p. Dep. CFSTI.

CESIUM ISOTOPES Cs-137—release from failed TRISO coated uranium oxide (UO_2) fuel particles
CESIUM—removal by NSPP spray system, effectiveness of Run 67 to Run 70
CHARCOAL—combustion of, effects of fission product decay heat on
DATA ACQUISITION SYSTEMS—operation of Nuclear Safety Information Center, during July to August 1969
FILTER MATERIALS—performance of HEPA, measurement of stainless steel–uranium oxide (UO_2) aerosol removal
GRAPHITE—corrosion by steam, (FIT)
INFORMATION CENTERS—operation of Nuclear Safety, during July to August 1969
METHANE, IODO-—removal by sodium thiosulfate, effects of additives on
NOZZLES—stresses in multiple and single cylindrical and spherical shell connected, effects of configuration on
NUCLEAR SAFETY PILOT PLANT—removal of cesium and uranium particles from
PIPE FITTINGS—tensile properties of ASA B16.9 tees
REACTOR FUEL ELEMENTS—swelling of Zircaloy clad rod type, effects of coolant loss conditions on
—failure of TRISO coated uranium oxide (UO_2), measurement of cesium-137 release in
REACTOR SAFETY—research and development program during July to August 1969, analysis of ORNL
SODIUM THIOSULFATE—reaction with methyl iodide, effects of additives on
STAINLESS STEEL—stainless steel–UO_2, performances of HEPA material for removal of, aerosols of
STEAM—corrosive effects on graphite, (E/T)
STEEL—tensile properties of A533 HSST, effects of thickness on
URANIUM—removal by NSPP spray system, effectiveness of Run 67 to Run 70
URANIUM OXIDES UO_2—performance of HEPA material for removal of, aerosols of
ZIRCALOY—mechanical properties of, measurement of high temperature (D.C.C.)

4078 NUCLEAR SAFEGUARDS. 1. THE IAEA PROGRAM. Sharpe, Bernard W. Phys. Today, 22: No. 11, 33-7(Nov. 1969).

A description of the International Atomic Energy Agency nuclear materials management safeguards organization and procedures is presented. Future requirements for safeguards are reviewed. (D.C.C.)

4079 NUCLEAR SAFEGUARDS. 2. THE US PROGRAM. Higinbotham, William A. Phys. Today, 22: No. 11, 40-4(Nov. 1969).

A description of the Atomic Energy Commission nuclear materials management safeguards organization and procedures is presented. Techniques for improving monitoring procedures are described. 4 references. (D.C.C.)

4080 ACCIDENTS AT ATOMIC FACILITIES. Hattori, Manabu (Rikkyo Univ., Yokosuka, Japan). Genshiryoku Kogyo, 15: No. 3, 20-2(Mar. 1969). (In Japanese).

The type, nature, and number of accidents in atomic facilities in the world are analyzed, based on the report Partial List of Accidents Involving Radiation by L. Goodman and others. Two hundred seventy four accidents in reactors occurred in the world, from 1945 to 1967, including all kinds; the number has increased rapidly with the number of reactors. Concerning the way of classification of reactor accidents, it is not exact, because the kind of phenomenon, the location of accident, and so on are mixed. (NSA of Japan) (TSS)

4081 STUDIES ON REMOVAL OF RADIOIODINE BY ACTIVATED CARBON. II. REMOVAL EFFICIENCY OF CHARCOAL FILTER FOR IODINE AND METHYL IODIDE. Murata, Toshifumi; Kamiya, Kunio (Hitachi Ltd., Tokyo). Nippon Genshiryoku Gakkaishi, 11: 612-17(1969). (In Japanese).

The removal efficiency of a charcoal filter for iodine and methyl iodide under simulated reactor accident conditions is evaluated. A charcoal filter of 8.0 cm dia was prepared for the test, and its efficiency determined under various operational conditions, using radioactive iodine as tracer. The principal variables applied in the measurements, were temperature, relative humidity, concentrations of iodine and methyl iodide as well as the surface velocity of the sweeping air. From the results obtained, an equation expressing the overall efficiency of the charcoal filter was derived for the case when a small amount of methyl iodide is present. (auth)

4082 NUCLEAR REACTOR CONTAINMENT STRUCTURES. (to Stone and Webster Engineering Corp.). British Patent 1,169,385. 5 Nov 1969. Priority date 12 Jul 1966, United States.

REACTOR CONTAINMENT STRUCTURES—pressure suppression in, steam condensation by reservoir of low specific gravity liquid for
REACTOR SAFETY—coolant loss accidents in water cooled reactors, method for pressure suppression following
REACTORS, WATER COOLED—containment structures for, method for suppression of accident produced steam pressure in (H.D.R.)

Power Conversion Systems

4083 (AEEW-R-641) NOISE SPECTRA MEASURED ON THE DRAGON REACTOR PRIMARY HEAT EXCHANGERS. Cummins, J. D. (Atomic Energy Establishment, Winfrith (England)). Sept. 1969. 41p. (DPR-632). Dep. CFSTI (U. S. Sales Only). UK 6s. 0d.

The frequency spectra of secondary water flow and tube wall temperatures have been measured on Dragon primary heat exchangers. No indication of tube wall temperature oscillations leading to tube burnout was found from the noise spectra analyzed. (auth) (UK)

Research and Test Reactors

Refer also to abstracts 2382, 2868, 2922, 2923, 2971, 3993, 3994, 4015, 4016, 4023, 4039, 4073, 4080, and 4151.

4084 (ANL-7107) PRESSURE TRANSDUCERS FOR TREAT SODIUM LOOPS. Robinson, L. E.; Purviance, R. T. (Argonne National Lab., Ill.). June 1969. Contract W-31-109-eng-38. 14p. Dep. CFSTI.

The Fast Reactor Safety meltdown program on advanced fuels in high-temperature Na required the development of specialized instrumentation to measure transient pressure. Conventional, commercially available strainbridge pressure transducers were successfully adapted to in-pile pressure measurement on high-temperature Na-filled loops, through the use of a NaK liquid-column isolation technique. Developmental testing of the transduction system included steady-state and dynamic tests with a shock tube and a Mark-1 integral Na loop. 6 references. (auth)

4085 (ANL-EBR-4) CONCEPTUAL SYSTEM DESIGN DESCRIPTION OF THE EBR-II IN-CORE INSTRUMENT TEST FACILITY. EBR-II Project. Seim, O.; Hutter, E.; Sullivan, T.; Olp, R.; Pardini, J.; Filewicz, E.; Brubaker, R. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). June 1969. Contract W-31-109-eng-38. 70p. Dep. CFSTI.

The results of a feasibility study for an EBR-2 test facility for studying reactor operating-conditions effects on instrumentation and cabling are discussed. Requirements for the experimenter's criteria are outlined. A brief description of the EBR-2 is given. Methods of heating and cooling the experimental thimble assembly are discussed and evaluated. Sensor test temperature analyses are detailed; calculated data are shown graphically. Methods for data acquisition and sensor calibration are described. Safety aspects of the test loop are evaluated. (M.L.S.)

4086 (BNWL-1028) AIR LEAKAGE RATE STUDIES ON THE C.S.E. CONTAINMENT VESSEL. Witherspoon, M. E.; Rogers, G. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1969. Contract AT(45-1)-1830. 144p. Dep. CFSTI.

A series of air leakage rate tests were performed as part of the Containment Systems Experiment program. The 30,700 ft^3 model containment vessel was tested at three nominal leakage rates and several pressures at each leakage rate. Leakage rate determinations were made using the Perfect Gas Law, the reference vessel method, and by collection of leakage through individual leakage paths. Error analyses, pressure characteristics of leakage rates, results of extrapolations, statistical analyses, comparisons of observed and predicted errors, and general observations are described. 10 references. (auth)

4087 (BNWL-1036) DESIGN SURVEY AND CONCEPTUAL DEFINITION OF A REACTIVITY OSCILLATOR FOR THE FAST TEST REACTOR. Telford, P. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1969. Contract AT(45-1)-1830. 37p. Dep. CFSTI.

A survey was completed of reactivity oscillators that have been designed for various nuclear reactors. The experience accumulated by each design was reviewed. Previously successful, specific design features or choices were selected and recommended for initial guidance to the designer of an oscillator for the Fast Test Reactor (FTR). A conceptual definition embodying the selected design choices was generated. (auth)

4088 (CISE-R-100) PRELIMINARY REPORT ON URANIUM METAL TUBE CLUSTER-HEAVY WATER LATTICE MEASUREMENTS. Topical Report No. 2. Accinni, F.; Palazzi, F.; Zorzoli, G. B. (Centro Informazioni Studi Esperienze, Milan (Italy)). Feb. 1964. Contract 005-63-7-NTRI. 58p. Dep. CFSTI (U. S. Sales Only).

The preliminary work of setting up a program of buckling and fine flux measurements on heavy water lattices with fuel elements made up of a seven uranium tube cluster and with polystyrene to simulate the actual coolant is described. The philosophy which led to the choice of the set of experimental configurations, the fuel element design and the results of preliminary calculations and calibrations are given in detail. 25 references. (auth)

4089 (GA-8091) THERMIONIC CRITICAL EXPERIMENT: DESCRIPTION AND SAFETY ANALYSIS. Cohen, S.; Moore, R.; Russell, J.; Young, J. (Gulf General Atomic, Inc., San Diego, Calif.). July 17, 1967. Contract AT(04-3)-167. 103p. Dep. CFSTI.

A description of the site and design parameters of the facility are presented. The safety and interlock systems are described. Operating rules and emergency procedures are reviewed. Safety regulations are described. 21 references. (D.C.C.)

4090 (NR-1090) FUEL TEMPERATURE TRANSIENTS IN EWA-2 AND EWA-4 CORES AT FLOW FAILURE AND RAMP REACTIVITY ADDITION TESTS. Czerniewski, M.; Labno, L. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 30p. Dep. CFSTI (U. S. Sales Only).

A program for EK-10 type fuel rod temperature measurements was performed in the EWA-2 and EWA-4 cores. The behavior of the reactor during transient states was investigated in two series of measurements. In the first series an open box type of the fuel assemblies for the core of 2 MW power reactor were used. The second series was performed with the fuel assemblies equipped with Venturi tubes inside of which the fuel rods had been placed. This type of fuel assemblies is used for the core of a 4 MW power reactor. Results are described. 7 references. (auth)

4091 (NP-18042) THIRTEENTH ANNUAL REPORT, 1968/69. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1969. 65p. Dep. CFSTI (U. S. Sales Only).

Activities of the Danish Atomic Energy Commission and the Risö research establishment for the period April 1, 1968, to March 31, 1969, are summarized. The operations of the various facilities at the research establishment are reviewed. Operating staff levels and financial data are tabulated, selected publications are listed, and design data on the research facilities are presented. (H.D.R.)

4092 (ORNL-TM-2505) PROBLEMS WITH THE HFIR CONTROL ROD DRIVES AND THEIR SOLUTIONS. Fraas, A. P.; Abbatiello, A. A. (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 161p. Dep. CFSTI.

The only serious difficulties encountered in nearly three years of shakedown and operating experience with the HFIR have involved elements of the control drive mechanism. These difficulties have stemmed from a classical case of the subtle interaction of complex phenomena in ways that proved difficult to observe although their effects were obvious, that is, broken bearing support lugs and worm bearings. The symptoms observed, the analyses and tests conducted in the course of the diagnosis, and the changes made to solve the problems are described. 34 references. (auth)

4093 (ORNL-TM-2735) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, APRIL-JUNE 1969. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). Oct. 1, 1969. Contract W-7405-eng-26. 60p. Dep. CFSTI.

Operations and maintenance requirements during April to June 1969 are described. Special tests are discussed. Calibration plots for shim rods and flux profiles are included. (D.C.C.)

4094 TRANSFER FUNCTION MEASUREMENTS IN A TWO ZONE REACTOR. Jeffers, D. E. (Univ. of Manchester, Eng.); Humphreys, E. Nukleonik, 12: 284-6(Oct. 1969).

The transfer functions relating flux oscillations in the two cores of an Argonaut type reactor have been measured and used to calculate the coupling and delay time between the two cores. (auth)

4095 OSIRIS REACTOR OPERATION FROM 1966 TO 1969. Graf, J.-J. Energ. Nucl. (Paris), 11: 334-9(Aug.-Sept. 1969). (In French).

Osiris, a swimming pool reactor designed for experimentation and material testing, started working in Saclay in September 1966. It has been in regular operation at 50 MW and, since the end of 1968, at 70 MW. The schedule of the reactor operation and experimentation is described. (auth)

4096 RADIOCHEMICAL DETERMINATION OF FISSION RATE IN JRR-4. Morozumi, Minoru; Natsume, Haruo; Sato, Tadashi; Suzuki, Toshio; Tomabechi, Ken; Umezawa, Hirokazu (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo), 6: 551-6(Oct. 1969).

The fission rate in the core of the Japan Research Reactor 4 (JRR-4) was determined by a method based on radiochemical analysis of ^{99}Mo formed in the U samples irradiated in the reactor core. The contribution of epithermal neutron fission to the total fission rate was evaluated from the Cd ratio for U fission. The contribution was several percent. For comparison, the thermal neutron flux also was measured, by Au-foil activation. The fission rate determined from the U samples agreed well with the Au-foil data, except at positions in the peripheral region of the reactor core. 12 references. (auth)

4097 EXPERIMENTAL AND THEORETICAL STUDIES OF SPACE-TIME NUCLEAR REACTOR KINETICS. Hassan, Hassan Abdel Halim. Urbana, Ill., Univ. of Illinois, 1968. 147p.

Thesis.

Experimental studies of space-time dependent kinetics in multiplying and nonmultiplying media are reported. A heavy-water-moderated, natural uranium subcritical assembly was used for the experiments. The assembly was 4 feet square by 5 feet long and was coupled to the Illinois TRIGA reactor through the main graphite thermal column. Thus, the TRIGA reactor served as a pulsed source of neutrons. The experimental data were obtained for fast transient pulses having periods ranging from 4.5 to 9.0 msec, and the full width at half maximum varied from 16.0 to 30 msec. The experiments were carried out for two square-lattice arrangements, which had 4.0-inch and 2.82-inch center-to-center fuel spacings. Also, the experiments were conducted with pure D_2O only. The approximate values of k_{eff} for these loadings were about 0.92, 0.76, and 0.0, respectively. The experiments had two objectives: to determine the accuracy and validity of space-time dependent analyses, and to test the coupled core reactor theories. WIGLE, a space-time dependent diffusion theory computer program, widely used in reactor kinetic studies, was selected as a representative space-time analytic technique. It was used to generate pulse shapes based on a one-dimensional "mockup" of the reactor core, the graphite thermal column, and the subcritical assembly. The pulse shapes, the dynamic relaxation length, the full width at half maximum, the delay times, and the asymptotic velocity of propagation in the assembly were compared with the experimental results. (Disser. Abstr.)

4098 APPRAISAL STUDY OF REPORTED EXPERIENCES OF VARIOUS FAST BREEDER REACTORS IN THE WORLD. VI. EBR-1. Nakagawa, Hiroshi; Futami, Tsuneo (Tokyo Electric Power Co., Inc.). Nippon Genshiryoku Gakkaishi, 11: 626-31 (1969). (In Japanese).

As a sequel to a preceding report, the operating experience of the EBR-I is reviewed and evaluated. (auth)

4099 DEVICE FOR IRRADIATING A CAPSULE. Nakai, Yasushi (to Mitsubishi Atomic Power Industry, Inc.). Japanese Patent 1969-9959. May 9, 1969. Filed June 29, 1965.

In the proposed capsule-irradiation device installed in a reactor experimental facility, the cooling of a capsule is considerably increased, thereby making possible the high-intensity irradiation of a capsule. The experimental irradiation tube extends vertically into the reactor pool water, after penetrating the upper concrete shield; the lower end of the tube opens into the water. Cooling water is circulated through the tube, entering at the bottom end and leaving it through holes cut in the upper part of the tube. A capsule is set just inside the open bottom end of the tube; the capsule is rotatable by the attached blades to which the flowing water pressure is applied. In order to obtain a turbulent coolant flow through the experimenting hole, a rotating impeller is installed within the tube, just inside the tube-wall holes. In this way, the capsule and samples in it can be cooled very efficiently. (NSA of Japan)

4100 DOPPLER EFFECT MEASUREMENTS IN POLYETHYLENE-SOFTENED REACTOR SPECTRA. Pond, Raymond Bigelow. Columbus, Ohio, Ohio State Univ., 1968. 142p.

Thesis.

Doppler effect measurements have been made in four progressively softer, polyethylene moderated reactor spectra designated as Assemblies 13, 14, 16 and 17 in the ZPR-9 reactor facility. Assemblies 13, 14, and 16 were constructed in a zoned-configuration with test, buffer, driver, and reflector regions. Assembly 17 had a uniform test zone without buffer or driver regions. Polyethylene was maintained in the test region at 8.7 volume percent with spectral softening accomplished by systematically substituting graphite for depleted U in this region. In Assemblies 13, 14, and 16 the test region had a nominal 26 cm radius and had $^{238}U/^{235}U$ ratios of 5/1, 4/1, and 3/1, respectively. In Assembly 17 the test region had a nominal 27 cm radius and contained virtually no ^{238}U. All measurements were made at the center of the test zone. The sample oscillation-reactivity difference technique was used to measure the Doppler effect in 1 in. dia. by 12 in. long, nominally 1 kg UO_2 samples which were highly enriched in either ^{238}U or ^{235}U. Expansion reactivity effects in ^{235}U were also measured. The measured and calculated ^{238}U Doppler effects were generally in consistent agreement considering the assumptions made in the calculations. Central material reactivity worths were also measured in these assemblies and compared with calculations. (Disser. Abstr.)

4101 CALCULATION AND MEASURING OF THE NEUTRON SPECTRUM IN THE DEMOCRITOS REACTOR. Jawas, G.; Jannussis, A. (Democritos Nuclear Research Center, Athens). Atompraxis, 15: 334-8 (Sept.-Oct. 1969). (In German).

The epithermal and fast neutron spectrum of the Democritos Reactor is calculated. The calculations are based on an infinite, homogeneous, light water moderated reactor model and are compared with the measurements by use of threshold detectors. In the energy interval between 1 keV and 1 MeV, where measurements are not possible, interpolation is carried out according to the calculated distribution and the interpolation method by Genthon. 16 references. (auth)

4102 BURST CAN DETECTION SYSTEM IN THE FR 2. Jacobi, S. (Nuclear Research Center, Karlsruhe, Ger.). pp 81-106 of Detection and Location of Failed Fuel Elements. Vienna, International Atomic Energy Agency, 1968.

From Conference on Failed Fuel Element Detection, Vienna, Austria. See STI/PUB-204; CONF-671119.

The burst can detection system in the FR2 is described. The system is based on the principle of precipitating the solid daughters of gaseous fission products. Starting from the main data of the FR2, the individual components of the detection system and various types of precipitators are described and some experimental results are presented and discussed. Former and present uranium contaminations of the FR2 as well as the isotopic composition of the precipitate are stated. 29 references. (auth)

4103 DETECTION AND LOCALIZATION OF A FUEL ELEMENT WITH A SIMULATED FAILURE IN THE FR 2. Golly, W.; Jacobi, S. (Nuclear Research Center, Karlsruhe, Ger.). pp 107-28 of Detection and Location of Failed Fuel Elements. Vienna, International Atomic Energy Agency, 1968.

From Conference on Failed Fuel Element Detection, Vienna, Austria. See STI/PUB-204; CONF-671119.

A hole of 1 mm^2 cross-section was made in the cladding of a UO_2 fuel-element pin before it was installed in the reactor FR2. The reactor was operated for 10 weeks with the damaged fuel element and a burst can detection system. It was shown that fission products were released after every start-up of the reactor. These releases, as well as the bursts during normal operation of the reactor, differ very much in intensity. 7 references. (auth)

Rocket and Space Reactors

Refer also to abstracts 2337, 2517, 2870, and 4080.

4104 (AD-692113) THE FEASIBILITY OF THE GASEOUS-CORE NUCLEAR REACTOR FOR ELECTRIC-POWER GENERATION. Gritton, E. C.; Pinkel, B. (RAND Corp., Santa Monica, Calif.). June 1969. Contract F44620-67-C-0045. 74p. (RM-5721-PR). CFSTI.

An examination of the potential of the gaseous-core nuclear reactor as a means of generating electric power is presented. An analysis of the radiation-heat-transfer process in the core of a gaseous-core power-production reactor is combined with an estimate of the quantity of uranium required for criticality to determine the core pressure and temperature for various values of power generation and core diameters, with varying assumptions as to the effects of ionization of the fissile gas and the uncertainty of the Rosseland mean opacity. Even under the most unfavorable assumptions, attractive power levels can be obtained in reactors of practical size at gas pressures and wall temperatures that present structural materials can contain. The extreme operating endurance and high power densities of the power system make it attractive for space as well as terrestrial power generation. (auth) (USGRDR)

4105 CRITICALITY STUDIES OF A NUCLEAR LIGHT BULB ENGINE. Latham, Thomas S. (United Aircraft Research Labs., East Hartford, Conn.). J. Spacecraft Rockets, 6: 1148-54(Oct. 1969).

Critical masses of ^{233}U fuel are calculated for a seven-cavity, nuclear light bulb engine in which energy is transferred by thermal radiation from gaseous nuclear fuel through internally cooled transparent walls to seeded hydrogen propellant. Each of the engine cavities is 6 ft long and 2.3 ft in diameter. BeO is employed between the unit cavities, and layers of BeO and graphite surround the seven units to provide neutron reflection. Effects of variations in the total moderator mass, the amount of BeO between unit cavities, the ratio of end wall to radial moderator mass, the amount of tungsten seed in the hydrogen propellant, and the amount of hafnium required to shield fuel injection and recirculation system ducts are evaluated analytically. The analysis also includes factors affecting the kinetic behavior of a nuclear light bulb engine: variations in fuel region radius, mixed mean propellant temperature, nominal system operating temperature, system operating pressure, and the proportion by weight of tungsten seen in the hydrogen propellant. For one specific nuclear light bulb engine, prompt neutron lifetime from two-dimensional

neutron diffusion theory is calculated to be 0.52 msec, and comparable critical masses for ^{233}U, ^{235}U, and ^{239}Pu are 35, 50, and 46 lb, respectively, from one-dimensional neutron transport theory calculations. 13 references. (auth)

4106 NUCLEAR REACTOR INSTALLATIONS. (to Siemens Aktiengesellschaft). British Patent 1,158,848. July 23, 1969. Priority date Oct. 21, 1965, Germany.

NUCLEAR AUXILIARY POWER SYSTEMS—design of space thermionic reactor with converter fuel elements and waste heat radiator

SPACE VEHICLES—power supplies of, design of thermionic reactor for (H.D.R.)

4107 FLOW EXPERIMENT ON A CURVED-POROUS-WALL GAS-CORE REACTOR GEOMETRY. Lanzo, Chester D. (Lewis Research Center, Cleveland). Nucl. Appl. Technol., 8: 6-12 (Jan. 1970).

Some recent experiments on an open cycle gaseous fueled nuclear rocket engine concept have been performed. In such an engine the gaseous fuel and the propellant are in direct contact. This feature removes the requirement of using solid fuel elements. These experiments have shown there is a relatively large central volume into which the simulated fuel expands. The fuel to cavity volume fraction depends on the propellant to fuel flow rate ratio. Fuel volume fractions varied from 0.5 to 0.3 as the mass flow ratio varied from 25 to 1 up to 100 to 1 respectively. (auth)

Process Heat and Desalination Reactors

Refer also to abstracts 2363, 2868, 2895, and 4080.

4108 WATER DESALTING, PRESENT AND FUTURE. Eliassen, Rolf (Stanford Univ., Calif. Metcalf and Eddy, Engrs., Palo Alto, Calif.). J. Amer. Water Works Ass., 61: 572-4(Nov. 1969).

The use of nuclear power plants for desalting water is analyzed. Desalting methods are described, and operating economics are compared for fossil fuel plants and nuclear power plants. 11 references. (D.C.C.)

4109 PROCEEDINGS OF THE INTERREGIONAL SEMINAR ON THE ECONOMIC APPLICATION OF WATER DESALINATION, NEW YORK, 22 SEPTEMBER–2 OCTOBER 1965. New York, United Nations, 1967. 371p. $4.50. (CONF-650999).

Included are 19 lectures on the potential of desalination plants as a means to facilitate economic development in water-short areas. Three reports are included on operational experience of desalination plants in the Bahamas, Kuwait, and the Virgin Islands. The economics of nuclear desalting is discussed. (H.D.R.)

4110 ECONOMICS OF DESALTING WATER AND GENERATING ELECTRICITY IN SINGAPORE. Bohl, William R.; Gillette, Jerry L.; Carbon, Max W. (Univ. of Wisconsin, Madison). Nucl. Appl. Technol., 8: 45-51(Jan. 1970).

Estimates were made of the cost of desalting water and generating electricity in the Republic of Singapore. These estimates were for both nuclear and fossil-fired plants. The results indicated that seawater could not be desalted for less than 50¢/1,000 gallons from dual-purpose plants of the largest size satisfactory for Singapore, i.e., about 200 MW(e) and 20 to 100 million gallons per day. This cost appeared approximately the same whether from nuclear or fossil-fired plants. The results also indicated that electricity could probably be generated at a somewhat-lower cost in a single-purpose fossil-fired plant than in a single-purpose nuclear unit. It was concluded that the use of nuclear energy did not appear to offer highly significant benefits to Singapore for desalting water or generating electricity during the next ten years. (auth)

4111 INDUSTRIAL NUCLEAR POWER PLANTS USING AGR. Meyer, L. (Brown, Boveri, and CIE, AG, Mannheim, Ger.). Atomwirt., Atomtech., 14: 397-400(Aug. 1969). (In German).

The potential of AGR-type reactors for dual-purpose plants producing both electricity and process steam is investigated. Thermal control circuit diagrams are shown for a one-stage installation producing 800 tons process steam per hour and a two-stage plant producing 1500 tons per hour. Operating and nuclear safety of AGR-type plants are discussed, and steam and electricity costs are calculated as a function of plant output. (H.D.R.)

4112 ASPECTS OF BUILDING AND MANAGEMENT OF NUCLEAR POWER PLANTS FOR PROCESS STEAM PRODUCTION. Wilck, A.-F. (Badisch Anilin- and Soda-Fabrik AG, Ludwigshafen, Ger.). Atomwirt., Atomtech., 14: 390-2(Aug. 1969). (In German).

Technical and economic aspects of dual-purpose nuclear plants for electricity and process steam production are examined. Safety and siting restrictions on nuclear installations are reviewed, and their effects on steam costs are discussed. Steam and power costs for nuclear plants and conventional oil-fired plants are compared. (H.D.R.)

4113 INDUSTRIAL NUCLEAR POWER USING BOILING WATER REACTORS. Mattern, J. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). Atomwirt., Atomtech., 14: 406-8(Aug. 1969). (In German).

Several aspects of a dual-purpose boiling water reactor for production of both electricity and process steam are analyzed. Two circuit diagrams for reactor, turbine, heat exchanger, and steam transformer are presented. The radiochemical purity of process steam is considered, especially under the assumption of defects in fuel elements. For detection of sudden damages in the heat exchanger, several scintillation counters measure ^{16}N gamma rays and close a safety valve in case of sudden increase in radioactivity. Problems of site selection are discussed. (H.B.G.)

4114 INDUSTRIAL NUCLEAR POWER PLANTS USING PRESSURIZED WATER REACTORS. Braun, W.; Martin, A. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 14: 400-6(Aug. 1969). (In German).

A pressurized water reactor, designed by Siemens, is described. Emphasized are easy accessibility of parts for repair and rapidity of fuel element changes. The reactor can be loaded with the entire set of 121 fuel elements within 18 hours. Basic diagrams for a dual purpose plant for production of both electricity and process steam are given. The basic design consists of two reactors to permit continuous operation if shutdown of one becomes necessary. Main characteristics for such a twin power plant are tabulated as to general properties, reactor core, pressure vessel, and cooling system. Production of process steam is described, and measures for control for radioactive contamination are given. Due to the fact that process steam is utilized in heavily populated areas, power plants must be located in or close to cities. The safety requirements caused by this proximity are discussed. (H.B.G.)

4115 ECONOMIC COMPARISON OF FOSSIL FUEL AND NUCLEAR POWER PLANTS FOR ELECTRICITY PRODUCTION AND PROCESS STEAM. Callsen, K. H. (Berichtsabfassung Kraftwerk Union AG, Erlangen, Ger.). Atomwirt., Atomtech., 14: 393-6(Aug. 1969). (In German).

The prospects for economical nuclear power plants for industry are investigated. Circuit diagrams for nuclear and oil-fired plants producing both electricity and process steam are presented. The nuclear plant consists of two 2000 MW(t) pressurized water reactors and the oil-fired plant has three units totaling 3220 MW(t). Power and process steam costs are calculated and compared for the reference plants. (H.D.R.)

Marine and Portable Power Reactors

Refer also to abstracts 2868, 2922, and 4080.

4116 (N-69-36757) PARAMETRIC STUDY OF LARGE NUCLEAR SURFACE EFFECTS MACHINES. Kascak, Albert F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1969. 41p. (NASA-TM-X-1888; E-4919). CFSTI.

Some performance estimates of a high speed peripheral jet nuclear powered surface effects machine are described. The calculations incorporate a recently proposed nuclear airplane reactor concept: this high temperature reactor reduces shield weight and eliminates a need for a heavy preheater. Payload fraction and reactor power are calculated for vehicle gross weights from 1000 to 5000 tons, forward velocities from 0 to 250 knots, and clearance heights from 10 to 50 ft. For these ranges, the payload varied from 0 to 60% of the gross weight, and the total reactor power varied from 400 to 10,000 NW. (auth) (STAR)

4117 SAFETY EVALUATION OF THE FIRST NUCLEAR SHIP IN JAPAN. Ando, Yoshio (Tokyo Univ.). Nucl. Eng. Design, 10: 243-9(June 1969).

The main results of the examination carried out by the Advisory Committee on Reactor Safeguards (ACRS) to evaluate the safety of the First Nuclear Ship in Japan are described. After analyzing the hazards in various cases of ship and reactor accidents, the

ACRS agreed that the safety of the ship could be secured. The results of a safety analysis on NS Savannah analyzed in accordance with the guide of Japan AEC are also presented. (auth)

4118 REACTOR PLANT DESIGN OF THE FIRST NUCLEAR SHIP IN JAPAN. Sato, Kago; Egusa, Tatsuo (Japan Nuclear Ship Development Agency, Tokyo). Nucl. Eng. Design, 10: 187-210 (June 1969).

The reactor design for the First Nuclear Ship in Japan is summarized, and basic information on general features of the reactor and its core, fuel assembly, control rods, pressure vessel, pressurizer and other heavy components is presented. Additional information provides a general description about the main installation of reactor auxiliary plant. (auth)

4119 ENVIRONMENTAL AND ON-BOARD TESTS OF THE INSTRUMENTS. Kurosawa, Akira (Japan Nuclear Ship Development Agency, Tokyo); Yokomura, Takeyoshi; Shirasawa, Takayasu. Nucl. Eng. Design, 10: 148-68 (June 1969).

The performance tests of nuclear measuring instruments and the radiation monitoring system were carried out by simulating the ship's conditions and the environmental conditions which would be encountered in the ocean. The pendulum type clinometer was trially made and the same tests were performed. Furthermore, some tests were done on board. As a result, some problems on the manufacture of those facilities on the first nuclear ship in Japan and on the adaptability for use were clarified. (auth)

4120 DIGITAL REACTIVITY MEASUREMENTS AT THE REACTOR OF NS "OTTO HAHN". Schwieger, E. (Gesellschaft fuer Kernenergieverwertung, Geesthacht-Tesperhude, Ger.). Atomkernenergie, 14: 371-4 (Nov.-Dec. 1969).

The results are presented of digital reactivity measurements obtained by the rod drive method for calibrating the control rods and to determine the isothermal reactivity coefficient. The computer program was checked by test calculations with reference to the evaluation of measurements with pulse detectors. 8 references. (auth)

4121 THE NUCLEAR EEL. Whitelaw, R. L. (Virginia Polytechnic Inst., Blacksburg, Va.). Mech. Eng., 91: 23-7 (Nov. 1969).

A description of a conceptual nuclear powered submarine cargo vessel named EEL is presented. The economic justification for operating vessels of this type is described. 7 references. (auth)

Production Reactors

Refer also to abstract 4080.

Reactor Theory

4122 CRITICALITY OF A URANIUM-SOLUTION SLAB UNDER VARIOUS REFLECTOR CONDITIONS. Rothe, Robert E.; Schuske, C. L.; Hicks, E. E. (Dow Chemical Co., Golden, Colo.). Nucl. Appl. Technol., 7: 505-12 (Dec. 1969).

Experimental data are presented to show the conditions under which a complex fissile system may be conservatively approximated by a simpler system. The complex system consists of an unpoisoned uranium-solution slab in contact, on one face, with a thick region of heavily boron-poisoned uranium solution. The simpler system consists of an unpoisoned uranium-solution slab reflected, on one face, by Plexiglas. A calculated correction to yield a similar result for water is also presented. Measured critical thicknesses are reported for U-solution slabs unreflected, reflected on one face only, and reflected on both faces by Plexiglas. These data and calculations on infinite solution slabs similarly reflected confirm that the critical height decreases linearly as the percent of the surface area reflected increases. (auth)

4123 PRACTICAL APPROACH TO NUCLEAR CRITICALITY SAFETY. Lewis, William Bradley. Nucl. Appl. Technol., 7: 523-8 (Dec. 1969).

Most problems of nuclear criticality safety correspond to an array of fissile units arranged in a definite pattern in a surrounding medium of specified composition. For an infinite array mathematical complications are greatly reduced, and a suitable model consists of: (1) a purely mathematical portion, (2) bulk material parameters, and (3) boundary parameters. The model can be tied to experimental data at one point by modifying a single material parameter. If the tie-in with integral data is made for systems of nearly the same neutronics, strictly geometric differences may be handled with considerable confidence. Several significant reactivities are discussed including that corresponding to an extremum in the spacing of units. (auth)

Kinetics

Refer also to abstracts 3827, 4088, and 4097.

4124 (CISE-R-113) AN ANALYTICAL METHOD FOR SOLVING A SYSTEM OF HELMHOLTZ EQUATIONS DERIVING FROM NEUTRON DIFFUSION PROBLEMS IN MULTI-REGION REACTORS. Topical Report No. 8. Bruschi, C.; Pierini, G.; Rubbia, S. (Centro Informazioni Studi Esperienze, Milan (Italy)). Aug. 1964. Contract 005-63-7-NTRI. 72p. Dep. CFSTI (U. S. Sales Only).

An analytical method is described which calculates the flux distribution in a multiregion cylindrical reactor by the two-group diffusion approximation. The method has the property of relating the flux vector on a given interface with the current vector on the same surface and has shown no numerical instabilities; moreover, the criticality search can be performed allowing for the variation of all the coefficients of the diffusion equations. Comparison with calculations performed by the finite difference technique has shown good agreement in numerical results. A generalization is also given which permits solving a system of four equations of the Helmholtz type in slab geometry. The usefulness of the latter solution is emphasized, by showing how it can be applied in setting up an approximate two-dimension, two-group solution of diffusion equations in a multiregion reactor by a variational or Galerkin synthesis technique. 4 references. (auth)

4125 (CISE-R-125) SOME REMARKS ON THE SURFACE RESONANCE ABSORPTION IN HETEROGENEOUS REACTORS. Topical Report No. 2. Bonalumi, R. (Centro Informazioni Studi Esperienze, Milan (Italy)). Sept. 1964. Contract 006-64-4-NTRI. 56p. Dep. CFSTI (U. S. Sales Only).

A formulation of the surface resonance absorption in heterogeneous reactors with a 1/E spectrum in the moderator is described using a first collision probability method. Explicit formulas are proposed for cluster fuel assemblies. Calculations are compared with experiments. 11 references. (auth)

4126 (GA-8272) BUG-2/BUGTRI: TWO DIMENSIONAL MULTIGROUP BURNUP CODES FOR RECTANGULAR AND HEXAGONAL GEOMETRY. Dorsey, J. P.; Froehlich, R.; Todt, F. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 22, 1969. Contract AT(04-3)-167. 235p. Dep. CFSTI.

The BUG-2 and BUGTRI codes and their use are described. Both BUG-2 and BUGTRI are UNIVAC-1108 two dimensional neutron diffusion-depletion programs which calculate the spatial distribution of the neutron flux, effective multiplication factor, and spatial composition of a reactor for a period of time and for the reactor operating conditions specified by the user. Flux, power distribution, and multiplication factor are computed using a non-uniform X-Y or R-Z mesh with BUG-2 or a uniform triangular mesh with BUGTRI. The diffusion programs each permit up to 20,000 meshpoints, as many as 255 different spatial regions having uniform macroscopic cross sections, and from one to ten energy groups with arbitrary group-to-group scattering. (auth)

4127 (KFK-983) CALCULATION OF DOPPLER COEFFICIENTS FOR FAST REACTORS. Siep, Irmgard (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Apr. 1969. 61p. (In German). (EUR-4179). Dep. CFSTI (U. S. Sales Only).

A complete documentation of the theoretical background of the Karlsruhe Doppler-Coefficient (DC)-Program is given. The theory has been changed in some aspects compared to the formalism given in the original description. At various points of the derivation of the formulas, generalizations of the theory are proposed. Results of the DC-Program are compared with Doppler coefficients calculated by successive-K-calculation and perturbation theory. The different results are discussed. (auth)

4128 (LA-4252) NUMERICAL INTEGRATION OF DYNAMIC NUCLEAR SYSTEMS EQUATIONS BY OPTIMUM INTEGRATING FACTORS. Secker, Phillip A. Jr. (Los Alamos Scientific Lab., N. Mex.). Apr. 1969. Contract W-7405-eng-36. 92p. Dep. CFSTI.

A numerical method, called the method of optimum integrating factors, is developed from a special integral equation solution of coupled first order nonlinear ordinary differential equation. An integrating factor with a complex exponent is formulated and a series approximation to the variable of integration is accomplished by expansion of the integrand in the integral equation into a Taylor series. The method is applied to step, ramp, and sinusoidal variations in reactivity for prompt and delayed neutrons; the method is also applied to an oscillating feedback condition. The integral equation, which serves as a basis for the integrating factor formulation, is derived and the integral functions are

evaluated. The expression for the relative truncation error is derived. A computer listing of the numerical integration subroutine is included. 22 references. (M.L.S.)

4129 ON A NEW METHOD FOR THE DETERMINATION OF KINETIC PARAMETERS IN ABSOLUTE UNITS. Kosaly, G.; Szatmary, Z. (Central Research Inst. for Physics, Budapest). Nukleonik, 12: 243-7(Oct. 1969).

After a short review of Mogilner's statistical weight concept and its applicability in reactor kinetics, a transport theoretical formulation is given. The main features and meaning of some basic quantities of the method are discussed. (auth)

4130 CRITERIA FOR STABILITY IN THE LARGE OF NUCLEAR REACTORS WITHOUT DELAYED NEUTRONS. Willems, J. L. (Univ. of Ghent). Nukleonik, 12: 248-51(Oct. 1969).

A criterion for the stability of nuclear reactors without delayed neutrons is presented. It is shown that this criterion is a generalization of the earlier criteria of Welton and Popov. The new property of the criterion is that it can prove stability in some cases where the frequency response of the reactivity feedback of the point reactor model goes in the third quadrant; this situation is never covered by the Popov or Welton criteria. A few examples illustrate the power and the limitations of the new criterion. Finally, it is shown that two different versions of the Popov criterion exist, and that this contradiction can be solved. (auth)

4131 SLOW TRANSIENTS OF THE NEUTRON FLUX IN A REACTOR CONTAINING REGIONS OF RANDOM MEDIA. Barrett, P. R. (Univ. of New South Wales, Kensington, Australia). Nukleonik, 12: 251-9(Oct. 1969).

For a regular array of identical lattice cells each transversely symmetric about its center and each containing regions of random media (such as boiling coolant and/or moderator), the expected average of the time-dependent neutron flux distribution is found by means of homogenized cell diffusion theory equations. The reactivity associated with the expected average behavior of each characteristic λ mode is determined for fluctuating conditions resulting mainly from the random nature of the boiling zones. The discussion is restricted to small variations about "critical" in order that additional feedback effects upon the nuclear density distribution in the random media may be neglected. A "critical" condition is defined and is compared with potential alternative definitions. It is shown that the definitions of the "critical" condition and of the expected reactivity lead to a non-ambiguous means for the formulation of an optimum control law. (auth)

4132 REACTOR CELL CALCULATION BY ALBEDO METHOD. Vertes, Peter (Central Research Inst. for Physics, Budapest). Nukleonik, 12: 276-80(Oct. 1969).

The albedo method is applied to multiregion cell calculation problems. In this application the albedo method seems to be the generalization of the method developed by Amouyal, Benoist, and Horowitz. The method can be used for numerical calculations as well as for theoretical considerations. In order to illustrate the latter, the resonance absorption in a cylindrical cell is investigated. (auth)

4133 APPLICATION OF GROUP THEORY TO THE SOLUTION OF BOUNDARY VALUE PROBLEMS. Theophilou, Andreas; Tsilimigras, Pan (Democritus Nuclear Research Center, Athens). Nukleonik, 12: 280-4(Oct. 1969).

Some general remarks are given on the application of group theory to solving boundary value problems. Solutions of the wave equation are given when the boundary is a regular triangle or hexagon. Also the criticality condition for a nuclear reactor whose basis is a regular triangle is obtained. (auth)

4134 DEDUCTION OF KRASOVSKII'S INSTABILITY THEOREM FROM LA SALLE'S EXTENSION OF LIAPUNOV'S DIRECT METHOD AND AN APPLICATION TO NUCLEAR REACTOR KINETICS. Di Pasquantonio, F. (Centro Ricerche di Automatica, Milan); Kappel, F. Nukleonik, 12: 288-9(Oct. 1969).

An instability theorem due to Krasovskii is discussed. This theorem demands only a Liapunov function with a semidefinite derivative. This is of practical importance, for it is easier to find a Liapunov function with a semidefinite derivative rather than a function with a definite derivative. The version of Krasovskii's instability theorem given is applied to nuclear reactor kinetics. The example given shows that it may be possible to prove instability by Krasovskii's theorem but not by Liapunov's so-called First Theorem on Instability or by Chetaev's Theorem. It is shown that Krasovskii's theorem is contained in La Salle's stability theory for autonomous differential equations. This fact is demonstrated by a proof of Krasovskii's theorem which uses La Salle's theory. (auth)

4135 POPOV'S CRITERION FOR STABILITY IN THE LARGE OF NUCLEAR REACTORS WITH DELAYED NEUTRONS. Willems, J. L. (Univ. of Ghent). Nukleonik, 12: 287(Oct. 1969).

It is shown that Popov's criterion for asymptotic stability in the large of a nuclear point reactor model with delayed neutrons is also sufficient for its stability in the large when delayed neutrons are neglected. Consequently, the criterion does not take into account the stabilizing effect of the delayed neutrons. (auth)

4136 FISSION-PRODUCT TRANSPORT AT FUEL-CLAD INTERFACE. Rohal, Robert George. Cleveland, Case Western Reserve Univ., 1968. 132p.
Thesis.

Three analytical models were constructed which describe the transport of fission products at a fuel-clad interface. In the first model fission product diffusion was assumed to be the only transport mechanism. In the second model fission product diffusion and fuel diffusion were considered as the transport mechanisms. In the third model fission product diffusion, fuel diffusion, and fission product recoil were assumed to be the transport mechanisms. All three models consider fission products which are radioactively stable. The region studied was a semi-infinite fuel region directly adjacent to a semi-infinite clad region. Expressions for the diffused fission product concentration near the fuel-clad interface were derived for each model. These expressions were then evaluated to show how the fission product concentration varies near the fuel-clad interface for each model. It was found that there are conditions under which all three models give essentially the same result. It was also found that under certain conditions it is possible to obtain fission product concentration peaking in the cladding. (Disser. Abstr.)

4137 THE STUDY OF BOUNDEDNESS OF THE RESPONSE OF A NUCLEAR REACTOR USING VOLTERRA SERIES. Bansal, V. S. (Univ. of Glasgow). Proc. Inst. Elec. Eng. (London), 116: 2072-4(Dec. 1969).

Barrett has recently suggested the use of a Volterra series for the determination of the system-response bounds. This reduces a nonlinear differential equation to an ordinary algebraic equation, thus considerably facilitating the study of the convergence properties of a Volterra-series expansion. The effect of temperature feedback control on the growth of neutrons in a nuclear-power reactor is investigated. A sufficient condition for the boundedness of the response of the nuclear reactor subjected to an arbitrary, constantly acting, bounded input is derived. The nonzero initial conditions of the system have been taken into consideration, and their effects on the system response are clearly shown. (auth)

4138 NEUTRON RETHERMALIZATION IN A ONE-DIMENSIONAL LATTICE WITH A PERIODIC TEMPERATURE DISTRIBUTION. Jauho, Pekka; Silvennoinen, Pekka (Technical Univ., Helsinki). Nucl. Sci. Eng., 38: 125-30(Nov. 1969).

The neutron transport equation is solved in plane geometry for a moderator with a periodic temperature distribution using the synthetic scattering kernel of Williams. A simple correspondence between the new model and the heavy-gas model is found for physical quantities dependent on the first two eigenvalues of the kernel. A recursion procedure for solving the energy moments of the flux is also presented. The flux is determined by a method using singular eigenfunctions. Some numerical results for the mean energy of the flux as a function of the lattice length are presented for A = 8 or for A = 10 employing the heavy-gas model. In order to consider the effect of periodicity of the temperature distribution on the mean energy of the neutron spectrum obtained, the results are compared to the mean energy of the neutron spectrum in Kottwitz geometry. There is a considerable deviation for lattices with lengths of the order of the rethermalization length. In this respect, the lattices with lengths of the order of ten rethermalization lengths describe Kottwitz geometry fairly well. (auth)

4139 ON THE DERIVATION OF AVERY'S COUPLED REACTOR KINETICS EQUATIONS. Komata, Masaoki (Hitachi Ltd., Kawasaki, Japan). Nucl. Sci. Eng., 38: 193-204(Dec. 1969).

The mechanics of the derivation of Avery's coupled reactor kinetics equations are presented. The diffusion equation and its adjoint equation are expressed in the matrix form. Then the partial flux and the partial adjoint flux are defined explicitly. The neutron flux, introduced by Henry, is represented as an amplitude $T(t)$ times a shape function $\phi(r,t)$. The adiabatic approximation is adopted in the neutron-flux shape function. Using the commutation law between the diffusion operator and its adjoint operator, Avery's equations are derived from the time-dependent diffusion equations for the partial adjoint flux. The assumptions introduced are: the delayed-neutron fission spectrum is the same as the prompt-neutron fission spectrum; the neutron-

flux shape function is approximated by the adiabatic method; and the time constant of the amplitude T(t) is much smaller than the minimum time constant of the shape function $\psi(r,t)$ at that instant. As the result of these assumptions, the delay time associated with the transfer of neutron does not appear explicitly in Avery's equations. 15 references. (auth)

4140 USE OF THE PROMPT-JUMP APPROXIMATION IN FAST-REACTOR KINETICS. Goldstein, Rubin; Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 38: 94-103(Nov. 1969).

By means of approximate numerical solutions obtained from a first-order correction to the prompt-jump approximation, good agreement is found with exact numerical solutions of the kinetics equations. Accuracies of <0.1% are obtainable for iterative time steps of as much as 1 sec, provided the reactor remains below prompt-critical [i.e., $k(t) < \$1$]. The accuracy increases as $1/\beta \to 0$, i.e., as the prompt-neutron lifetime becomes smaller or as the reactor becomes "faster." This is true for both fast- and slow-reactivity insertion rates, C. Two methods for handling rapid reactivity insertion rates are discussed. One is more applicable for $C \approx 1 \to 50$ \$/sec, and the other is more applicable for $C \gtrsim 50$ \$/sec. In the one delayed-neutron-group approximation, analytic results are presented for arbitrary reactivity insertion rates and comparisons are made with previous methods. 10 references. (auth)

4141 STABILITY AND THE DEGREE OF STABILITY UNDER THE EFFECTS OF DELAYED NEUTRONS. Tan, Sevim (Middle East Technical Univ., Ankara). Nucl. Sci. Eng., 38: 167-9(Nov. 1969).

Characteristics of the Nyquist plots of reactor systems which are more stable under the effects of delayed neutrons are investigated. It is shown that all systems that are conditionally stable or absolutely stable when delayed neutrons are neglected are more stable under the influence of delayed neutrons. (H.D.R.)

4142 APPROXIMATE $J(\theta,\beta)$ FUNCTION. Steen, N. M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 38: 244-52(Dec. 1969).

A fast and accurate method of approximating the $J(\theta,\beta)$ function for a single resonance is presented. A rapid method of averaging unresolved levels by use of this approximate J function and a recently developed quadrature scheme of the Gaussian type is also presented. These approximations are well suited for use in day-to-day reactor design and evaluation and are substantially faster and more accurate than other approximations currently available. The approximate J function has been tested on that portion of the θ,β plane for which $\beta \geq 5.0 \times 10^{-5}$ and $\theta \geq 5.0 \times 10^{-4}$. This portion of the plane encompasses almost every conceivable practical situation. On this domain, typical relative errors incurred in $J(\theta,\beta)$ are 0.25% or less and the maximum relative error for any (θ,β) pair is 2.2% which is encountered at an extreme value of $\beta = 5.0 \times 10^{-5}$. The technique for J-function averaging produces relative errors <0.10% for cases of practical interest. 12 references. (auth)

4143 CONTROL OF XENON SPATIAL OSCILLATIONS. Stacey, Weston M. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 38: 229-43(Dec. 1969).

The problem of optimally controlling xenon spatial oscillations is formulated as a problem in the calculus of variations for distributed parameter systems. The resulting partial differential equations (space- and time-dependent) are then approximated by a nodal representation to obtain a set of ordinary differential equations (time-dependent) with mixed (initial and final) boundary conditions. An iterative solution scheme, which utilizes a quasi-linearization of the equations and a transformation matrix relating initial to final values of certain variables, is employed to obtain numerical results. Feasibility of the method is established by several sample calculations. A physical interpretation is given the Lagrange multiplier functions which initially are introduced for mathematical considerations. 11 references. (auth)

4144 REFLECTION AND TRANSMISSION FUNCTIONS IN REACTOR PHYSICS. Pfeiffer, W.; Shapiro, J. L. (California Inst. of Tech., Pasadena). Nucl. Sci. Eng., 38: 253-64(Dec. 1969).

The utility of reflection and transmission function (or collectively, response function) concepts in reactor physics is investigated. A review of previous work is given, indicating the relation between the differential (invariant imbedding) and functional (adding) equations for the response functions. In addition, a numerical halving technique is developed from the adding relations. By combining the invariant imbedding and functional equations, an efficient calculational technique for albedo, shielding, and criticality problems in slab geometry is obtained. The feasibility of performing response function experiments to obtain cross section and criticality information is also examined. The envisioned experimental setup is described and calculations are carried out to verify the numerical procedures. 66 references. (auth)

4145 TWO-GROUP NEUTRON TRANSPORT THEORY FOR A FINITE CRITICAL SLAB. Boffi, V. C.; Premuda, F. (Comitato Nazionale per l'Energia Nucleare, Bologna). Nucl. Sci. Eng., 38: 205-15(Dec. 1969).

A two energy group model is proposed for studying the criticality of a slab of finite thickness in the framework of neutron transport theory. The system of the two stationary Boltzmann equations which, in the case of isotropic scattering, govern the flux distributions of the two neutron groups, is first solved by a Fourier transform technique. Explicit series expressions are then derived for the angular as well as for the total flux distributions in the interior and at the boundary of the critical slab. These series expressions are shown by numerical calculations to be rapidly convergent to the required solutions of the problem under examination. Results for the critical parameter and for the total and angular flux distributions are reported. 10 references. (auth)

4146 COMPARISON OF MEASURED AND CALCULATED URANIUM REACTION RATES IN A STEAM-COOLED FAST ASSEMBLY IN SNEAK. Boehme, R.; Seufert, H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Appl. Technol., 7: 494-504(Dec. 1969).

An absolute determination of uranium reaction rates by means of foil irradiation was carried out in the Fast Zero Power Reactor SNEAK, assembly 3A-2. This requires the measurement of reaction rate traverses as well as their fine structure. These rate distributions were compared with transport and diffusion calculations. The traverse measurements indicate a strong dependence of the axial "buckling" (relative second derivative of the rates) on energy. The calculations with the Karlsruhe SNEAK cross section set and the Russian ABN set yield bucklings for ^{238}U capture and ^{235}U fission in diffusion approximation on the average 5% higher than measured. Only the fast fission rate distribution of ^{238}U is almost correctly calculated using these cross section sets. The ratio of total plutonium production to ^{235}U fission along the z-axis was measured and compared with theory. It agrees within the error limits of the experiment. Beyond the error limits are the discrepancies found for the spectral index $\sigma_f^{28}/\sigma_f^{25}$. The fine structure of reaction rates within the fuel platelets is well described by an integral transport code, but again there are considerable discrepancies between calculated and measured fission rate ratios. (auth)

4147 FIZIKA YADERNYKH REAKTOROV. VYPUSK 1. (Nuclear Reactor Physics. Part 1). Yurovoi, L. N. (ed.). Moscow, Atomizdat, 1968. 232p.

Subjects examined in the collection of articles include: (1) the mathematical basis of nuclear reactor operation; (2) effective synthetic methods for reactor calculations; (3) analytical methods of reactor calculations; (4) dynamics of reactors; (5) investigation of the diffusion characteristics of different media by the impulse method; (6) experimental investigation of the physics parameters of reactors. (112 references) (tr-auth)

4148 NEUTRON THERMALIZATION IN REACTOR CELL. Pop-Jordanov, J. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Kernenergie; 12: 288-94(Sept 1969).

One of the most important problems in neutron thermalization studies in reactor cells is that fast codes are usually approximate skipping too much of the intrinsic physics, while the more accurate ones are too slow. Improvements on thermalization models and numerical procedures are described. Some new developments in analytical polynomial and numerical discrete transport methods are presented and discussed. 23 references. (auth)

Dynamics

4149 (CISE-R-120) A DIGITAL APPROACH FOR TRANSFER FUNCTION COMPUTATION. Topical Report No. 13. Brusa, L.; Muscettola, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). June 1964. Contract 005-63-7-NTRI. 61p. Dep. CFSTI (U. S. Sales Only).

A mathematical formulation is derived for the numerical computation of transfer functions of multivariable systems. An application of this method to the dynamics of a two phase flow in a boiling channel is also described. 4 references. (auth)

4150 TREATMENT OF UNCERTAINTIES IN REACTOR HEAT TRANSFER CALCULATIONS. Reilly, Harry J. (Plum Brook Station, Sandusky, Ohio); Hansell, John D.; Heath, George L. Nucl. Sci. Eng., 38: 135-42(Nov. 1969).

A method of performing probability calculations for nuclear-reactor surface temperatures has been devised. The method gives consideration to the fact that some uncertainties may vary systematically over all the reactor or over some parts of it. The method does not depend on assumption of any particular form of the probability distributions. The method was used to do an example calculation for an MTR-type test reactor with plate-type fuel elements. It was shown that the calculated probability of failure, that is, that surface temperature exceeds coolant saturation temperature, lies closer to values obtained from the Deterministic Method than to values from the Statistical Method. The calculated probability value was identified as the probability of success at the instant of reactor startup. It was observed that the probability of success for continued operation might not be the same as the value for startup. (auth)

4151 POLARITY CORRELATION OF REACTOR NOISE IN THE FREQUENCY DOMAIN. Seifritz, W. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Appl. Technol., 7: 513-22 (Dec. 1969).

A newly developed special two-detector cross-correlation experiment of zero-power reactor noise analysis is applied to determining characteristic kinetic reactor parameters. This method, called polarity correlation in the frequency domain, is based on the detailed analysis of the stochastic coherence function, in contrast to the analysis of auto and/or crosspower spectral density functions. The coherence function is easily obtained by polarity correlation of two filtered random neutron noise signals simultaneously sampled in a reactor system using neutron sensitive detectors in the current mode of operation. The advantage in using this technique is both its simplicity and the automatic elimination of the equipment frequency response, which is of special importance when analyzing fast reactor noise spectra. A series of prompt neutron decay constant measurements were performed on several configurations of the STARK and SNEAK facilities. Moreover, special attention and effort is dedicated to reactivity shutdown measurements by the polarity correlation method. An on-line reactivity meter is described which is particularly suited to making reactivity measurements in large plutonium fueled reactors. Shutdown reactivity measurements were performed down to −8 dillars. 16 references. (auth)

Experimental Applications

Refer also to abstracts 2434 and 4038.

4152 (ANL-Trans-787) MEASUREMENTS OF BUCKLINGS BY THE PROGRESSIVE REPLACEMENT METHOD. Bacher, P.; Naudet, R. Translated for Argonne National Lab., Ill., from J. Nucl. Energy, Parts A and B, 13: 112-27(1961). 37p. Dep. CFSTI.

The use of the progressive substitution method for basic reactor physics measurements in the Aquilon zero-power heavy water reactor is described. The continuity equations for the neutron fluxes and currents are formulated in terms of two-group diffusion theory by taking the one-group equations and expanding to two groups. The physical interpretation of the critical experiments are discussed. Reflector corrections are described. Numerical examples are given, experimental verifications of these examples are described, and the precision of the experiments is evaluated. Measurement of differential effects is discussed. Utilization of the substitution method for graphite lattices is described. (M.L.S.)

4153 (JAERI-1176) PRODUCTION OF GROUP CONSTANT FOR REACTOR ANALYSIS. A Report on Activities in 1966–1967. (Japan Atomic Energy Research Inst., Tokyo). Sept. 1969. 179p. Dep. CFSTI (U. S. Sales Only).

A report on the production of group constants conducted during 1966 and 1967 is presented. Functions and characteristic features of the processing programs for converting nuclear data into group constants, analyzing resonance cross sections, evaluating angular distributions, and producing parameters of thermal cross sections are described. Comparisons of various nuclear data, such as those on thermal cross sections, epithermal and fast cross sections, inelastic scattering and the quantities related to fission neutrons are included. There were found many discrepancies and inconsistencies among various data. 7 references. (auth)

4154 (WAPD-TM-811) REDUX: A FORTRAN IV PROGRAM FOR CALCULATION OF STATISTICAL PARAMETERS FROM COUNT SAMPLES MEASURED IN REACTOR FLUCTUATION EXPERIMENTS. Harris, D. R.; Natelson, M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1969. Contract AT-11-1-GEN-14. 22p. Dep. CFSTI.

REDUX is a FORTRAN-IV program for reduction of data from reactor fluctuation experiments. From input count samples recorded by one or two counting channels, the program computes sample moments about the origin, unbiased estimates of central moments and cumulants of orders less than five, certain distribution characters such as skewness, excess of kurtosis and conventional coefficient of correlation, together with the dispersion parameter γ and modified coefficient of correlation MCC. Bias and standard error estimates are computed for γ and MCC. The program also computes these statistics for count samples formed by combining in various ways counts of the input count samples. 6 references. (auth)

4155 DETERMINATION OF β_{eff} BY THE METHOD OF STATISTICAL WEIGHTS AND BY MEASURING THE ABSOLUTE POWER OF THE REACTOR. Szatmary, Z.; Turi, L. (Central Research Inst. for Physics, Budapest). Nukleonik, 12: 241-3 (Oct. 1969).

After a short review of the measuring methods, typical measurements are presented. Their results are compared. (auth)

4156 NUMERICAL EVALUATION OF SPATIALLY DEPENDENT DYNAMIC REACTOR SYSTEMS USING PSEUDORANDOM SIGNALS. Rydin, R. A.; Hooper, R. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 38: 216-28(Dec. 1969).

The crosscorrelation method of determining the impulse response of a dynamic system, which has been widely used in experiments, is applied numerically to a complicated mathematical model of a spatially dependent reactor system, and is concluded to be a practical alternative to analog computer analysis. The method is applied using two families of periodic discrete level signals as the input perturbation. It is demonstrated that a relatively new class of signals, having three possible levels, which has had very limited use to date, leads to a more accurate determination of the impulse response in the presence of strong system nonlinearities than do the better known and more widely used binary signals. 14 references. (auth)

4157 EFFECT OF WATER GAPS ON VARIOUS NUCLEAR PARAMETERS OF A LIGHT-WATER REACTOR. Haga, Tohru (Hitachi, Ltd., Kawasaki, Japan). Nucl. Sci. Eng., 38: 104-13 (Nov. 1969).

Neutron density and importance distributions, β_{eff}/Λ and moderator temperature coefficients have been experimentally studied in connection with a central water gap of a light-water reactor having a water to UO_2 volume ratio of 1.5. Thermal importance functions are determined from the reactivity weighting function, while the fast importance functions are measured by a ^{252}Cf source introduction method. Values of β_{eff}/Λ measured by pulsed-neutron experiments decrease from 202 sec^{-1} in the uniform core to 185 sec^{-1} for the core with a water gap of 6.7 cm effective radius. It is also shown that the water gap influences the moderator temperature coefficient to a considerable extent. (auth)

4158 CALCULATION OF THE EFFECTS OF BEAM TUBES ON NEUTRON FLUX. Conkie, W. R. (Queen's Univ., Kingston, Ont. Chalk River Nuclear Labs., Ont.). Nucl. Sci. Eng., 38: 180-1(Nov. 1969).

A method for calculating the effects of various numbers, sizes, and orientations of beam tubes in depressing the undisturbed flux of thermal neutrons in a reactor is derived. The theory, based on a P_1 approximation, is shown to yield adequate results by a comparison with measured values. (H.D.R.)

4159 ENERGY-DEPENDENT REFLECTION COEFFICIENT FOR A CRITICAL CYLINDER OF AQUEOUS U(4.98) SOLUTION WITH COMPOSITE REFLECTOR. Newlon, C. E. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Nucl. Sci. Eng., 38: 173-4 (Nov. 1969).

The energy-dependent reflection coefficients for critical 33.09 cm dia cylinders of 4.98% enriched UO_2F_2 solution were calculated. Reflectors of steel, Cd, and water were placed around the lateral surfaces of the cylinders in various combinations. Results are displayed graphically. (H.D.R.)

4160 MEASUREMENTS OF LATTICE PARAMETERS WITH A SINGLE FUEL ASSEMBLY IN ORGANIC COOLANT MATERIAL. Matsubara, Takeo; Mukoyama, Takeshi; Tada, Hiromitsu; Tsuji, Yoshio. Nippon Genshiryoku Gakkaishi, 11: 600-5(1969). (In Japanese).

A method for determining lattice parameters with a single fuel assembly is discussed. The purpose of the experiments was to explore the possibility of applying the method to measurements in organic coolant systems. The apparatus used for the present study consisted of a cylindrical vessel (100 cm inner dia and 200 cm height) containing an organic coolant—Santowax OMP. The fuel assembly used was a 22-rod UO_2 cluster, fixed in the center of the cylindrical vessel. The data obtained were compared with the re-

sults calculated by computer using established nuclear data and codes. The discrepancy between the measured and calculated values was found to be within 2% in the lattice spaces of 16 cm and 20 cm. Thus the method would appear to be practically applicable to organic coolant systems, at least in the range of the lattice spaces covered by the experiment. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 2262, 2296, 2338, 2340, 2341, 2346, 2349–2352, 2361, 2362, 2364, 2371, 2377, 2378, 2390, 2409, 2521, 2868, 2873, 2875, 2897, 2920, 2930, 2974–2978, 2981–2985, 2995, 3004, 3015, 3023, 3041, 3047–3051, and 4023.

4161 (AECL–3380) UO_2 IMPREGNATED GRAPHITE FUEL ELEMENTS CLAD IN ZIRCALOY IRRADIATED TO BURNUPS OF 20 PERCENT FIFA. MacDonald, R. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1969. 41p. Dep. CFSTI (U. S. Sales Only). CAN $1.50.

Five elements clad in Zircaloy-4 and fuelled with UO_2-impregnated graphite were irradiated in the X-2 pressurized water loop. One of the elements was purposely defected to determine the fission product release into the loop coolant. Approximately two hours after reactor startup this element had to be removed because of excessive amounts of activity (mostly short-lived fission gases) in the coolant. The four remaining elements were irradiated until the maximum burnup for the most highly rated specimen reached approximately 20% FIFA and the lowest burnup was about 6% FIFA. Linear heat outputs for the four intact elements varied from 400 to 880 W/cm. Generally element diameters increased during irradiation while lengths contracted. The maximum sheath strain was 1.4% measured over the bulges at both ends of the two high burnup elements. These end bulges were attributed to gross dimensional changes in the graphite resulting from an increase in fission density caused by a higher fuel loading at the ends of the elements. Fuel volume changes varied from −1.1% for the element with the highest burnup to −4.9% for the element with the lowest burnup. Less fission gas was collected from the elements than was claculated to be released from the UO_2 particles by recoil; the largest releases were 5.3% for Kr and 1.0% for Xe. The maximum hydrogen concentration in either the sheaths or end caps was only 55 ppM H_2. 17 references. (auth)

4162 (AECL–3426) IN-REACTOR PRESSURE TUBE GAUGING EQUIPMENT. Widger, J.; Escott, J.; McManus, M.; Nelson, D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug. 1969. 28p. Dep. CFSTI (U. S. Sales Only). CAN $1.00.

Equipment was developed to measure the inside diameter, straightness, and surface defects of pressure tubes in a reactor. Inspections are carried out during reactor shutdown by inserting the measuring devices into the pressure tube which has been emptied of fuel and drained of coolant water. The new system produces a punched paper tape output which is processed by computer thereby replacing the manual calculating and plotting of the earlier system. The inside diameter gaging results are accurate to ±0.0003 in. and the surface roughness measurements to ±0.001 in. (auth)

4163 (CEA-CONF–1357) RELATION BETWEEN THE SWELLING OF METAL FUELS AND THE RELEASE OF FISSION GAS. Kryger, Bernard; Mikailoff, Hubert ([Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1967]. 7p. (In French). (CONF-671086–1). Dep. CFSTI (U. S. Sales Only).

From French-British Conference on the Metallurgy of Uranium, Harwell, England.

Some annular clad cylinders of U and U−8% Mo alloy were irradiated to a high burnup of 35,000 MWd/t. The central bore was filled by the swelling of the fuels. Failure was studied using measurements on rate of swelling, rate of creep, and internal distribution of fission gas bubbles. The importance of fission gas release in connection with the swelling and the nature of the materials is stressed. (P.C.H.)

4164 (GA–8566) SLIDER, A FORTRAN V PROGRAM FOR THE COMPUTATION OF THE RELEASE OF FISSION PRODUCTS FROM ONE-DIMENSIONAL MULTILAYERED FUEL CONFIGURATIONS. Jadhav, K. B.; Roos, B. W. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 1, 1969. Contract AT(04-3)-167. 60p. Dep. CFSTI.

The SLIDER computer program written in FORTRAN 5 is described. The program calculates transient and steady state releases of fission products from one-dimensional multilayered fuel configurations. (auth)

4165 (GA–9394) PWCOST: A GENERAL PURPOSE COMPUTER CODE FOR THE CALCULATION OF FUEL CYCLE COSTS. Lee, D. H. Jr. (Gulf General Atomic, Inc., San Diego, Calif.). 10 Jun 1969. Contract AT(04-3)-167. 115p. Dep. CFSTI.

PWCOST is a very flexible computer program for calculating nuclear reactor fuel cycle costs. It can be used for evaluating costs of a single fuel segment or for an entire reactor history. Input for all components of the fuel cycle are time dependent. Working capital charge rates may be specified separately for in-core and out-of-core time periods. Costs are calculated using a present-worth levelized approach. There are several accounting procedures available as options including the treatment of preirradiation working capital as an add-on to the front end services cost. The code also calculates the cost of a lease cycle and can evaluate a spent fuel buyback option. 9 references. (auth)

4166 (GAMD–9281) PARAMETRIC STUDY OF MULTIPLE-COLUMN SEISMIC SUPPORT FOR A LARGE PCRV. Smith, P. D. (Gulf General Atomic, Inc., San Diego, Calif.). May 7, 1969. Contract AT(04-3)-167. 69p. Dep. CFSTI.

Design requirements for multiple column supports of large prestressed concrete reactor pressure vessels are analyzed. Seismic stress analyses are included for supports of various configurations. 2 references. (auth)

4167 (GAMD–9282) SEISMIC STUDY OF SUPPORT CONCEPTS FOR PRESTRESSED CONCRETE REACTOR VESSELS. Smith, P. D.; Esztergar, E. P. (Gulf General Atomic, Inc., San Diego, Calif.). May 21, 1969. Contract AT(04-3)-167. 34p. Dep. CFSTI.

Design requirements for supports of large prestressed concrete reactor pressure vessels are analyzed. Several types of supports are described. 2 references. (auth)

4168 (GAMD–9283) INFLUENCE OF SEISMIC CONDITIONS ON THE SUPPORT DESIGN OF LARGE PRESTRESSED CONCRETE REACTOR VESSELS. Smith, P. D. (Gulf General Atomic, Inc., San Diego, Calif.). May 9, 1969. Contract AT(04-3)-167. 17p. Dep. CFSTI.

Design requirements for supports of large prestressed concrete reactor pressure vessels are analyzed. The effects of seismic stresses on design requirements are described. 3 references. (auth)

4169 TRANSIENT TEMPERATURE RESPONSE OF AN ANNULAR FLOW WITH STEP CHANGE IN HEAT GENERATING ROD. Namatame, Ken (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 6: 591-600 (Oct. 1969).

An analysis is made on the transient temperature response of fluid and of heat generating rod in the case of annular flow. Special consideration is given to the effects of the rod heat capacity and radial thermal conduction in the rod during the transient. The analysis is based on the following assumptions: initially the system has a uniform temperature distribution, and the rod undergoes a step change in heat generation; the temperature of the fluid entering the annular space is kept constant; the velocity distribution of fluid is uniform; all physical properties remain unchanged during the transient; axial thermal conduction in the rod is neglected in comparison with that in the radial direction; and axial thermal conduction in the fluid is neglected in comparison with axial thermal convection. Results are compared with values by quasi-static solution for various heat transfer parameters. 17 references. (auth)

4170 IMPROVEMENTS IN AND RELATING TO A PRESTRESSED CONCRETE PRESSURE VESSEL. Costes, Didier; Tomaghevsky, Eric (to Commissariat a l'Energie Atomique). British Patent 1,159,464. July 23, 1969. Priority date June 20, 1966, France.

PRESSURE VESSELS—prestressing of reactor cylindrical concrete, system for longitudinal and peripheral
REACTORS, GAS COOLED—pressure vessel for, prestressing method for cylindrical concrete (H.D.R.)

4171 IMPROVEMENTS IN OR RELATING TO CHARGE-DISCHARGE DEVICES FOR VERTICAL-CHANNEL NUCLEAR REACTORS. Farfaletti-Casali, Flaviano; Dufresne, Jacques (to EURATOM). British Patent 1,162,418. Aug. 27, 1969. Priority date Oct. 6, 1966, Belgium.

REACTOR LOADING MACHINES—design parameters of flexible tube connected vertical channel (D.C.C.)

4172 DRIVE AND COUPLING APPARATUS FOR A CONTROL ELEMENT OF A NUCLEAR REACTOR. (to Combustion Engineering, Inc.) British Patent 1,169,139. Oct. 29, 1969. Priority date Oct. 10, 1967, United States.

REACTOR CONTROL ELEMENTS—drives for, description of parallel overhead vertical gear regulated offset (D.C.C.)

4173 IN-REACTOR CONTROL DRIVE SYSTEM. Ripley, Charles C. (to U. S. Atomic Energy Commission). U. S. Patent 3,479,250. Nov. 18, 1969.

A nuclear reactor control drive system is described in which a fluidic amplifier for switching a force-transmitting fluid is located at the base of a piston-driven control rod assembly in a nuclear reactor having two tubes. One tube connects with the bottom of the control rod and piston, and the other tube connects with the top of the control rod and piston. A fluid signal into the amplifier diverts the flow of a force-transmitting fluid from one tube to the other to either raise or lower the control rod by hydraulic pressure of the flowing force-transmitting fluid against the piston. (AEC)

4174 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). U. S. Patent 3,477,909. Nov. 11, 1969. Priority date May 15, 1967, Great Britain.

A nuclear reactor fuel element assembly is described which has a cluster of parallel fuel elements spaced apart by cellular grids. The cells of the grids are off-set from their nominal positions about the longitudinal axis of the cluster to ensure that each grid bears against each element. The cells are arranged in two groups off-set in opposite directions so that turning moments on the grid are balanced. (Offic. Gaz.)

4175 IN-PILE FUEL STUDIES FOR DESIGN PURPOSES. Testa, G.; Doria, F.; Grillo, P.; Nobili, A.; Rotoloni, P. L. (Comitato Nazionale per l'Energia Nucleare, Rome). Nucl. Appl. Technol., 7: 550-60(Dec. 1969).

The CNEN Plutonium Program has the principal purpose of developing the technology necessary for manufacturing Pu-containing fuel elements for testing in a light water reactor. As a part of the program, experiments were carried out in the Halden Boiling Reactor on Zircaloy-clad UO_2 fuel with the aim of obtaining some essential parameters for the Pu fuel rod design. Four test assemblies were irradiated in Halden. Two assemblies consist of 12 rods each and contain UO_2 at 6 wt. % of ^{235}U in the form of pelleted and vibrocompacted fuel. The other two assemblies consist of 2 rods each and contain UO_2 at 10 wt. % of ^{235}U in pelleted and vibrocompacted fuel form. The test assemblies are instrumented with thermocouples for measuring central fuel temperature and with transducers for measuring fission gas release pressure. Test procedures and results are described for the comparative performance of pelleted and vibrocompacted fuels, for the fuel density effect on the oxide thermal conductivity, and for the effect of the cold diametral gap on the gap heat conductance. (H.D.R.)

4176 MODELS FOR FISSION-GAS RELEASE FROM PYROCARBON-COATED PARTICLES. Baumann, C. D.; Reagan, P. E. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol., 7: 537-49(Dec. 1969).

Mathematical models describing idealized mechanisms of fission-gas release were used as criteria to determine the mode of release from fully enriched UC_2-fueled pyrocarbon coated particles which had slightly ^{235}U-contaminated outer coatings. Below 1600°C the release of Kr, and probably I_2 and Xe was due to fissions which occurred in the contaminated outer coating, with the products escaping by solid-state diffusion from the coating. Above 1600°C the Kr release increased more rapidly with temperature. The Kr originated in the fuel core and traversed the outer coating either by solid-state diffusion or Knudsen flow through micropores in the outer coating. The overall increase in release rate with time was probably due to migration of the ^{235}U initially in the outer coating, and to the over five-fold increase in ^{235}U contamination of the outer coating during irradiation. (auth)

4177 METHOD AND APPARATUS FOR LOCATING RUPTURED FUEL ELEMENTS IN A NUCLEAR REACTOR. (to Atomic Energy of Canada Ltd.). British Patent 1,170,550. 12 Nov 1969. Priority date 13 Oct 1966, Canada.

FISSION PRODUCTS—monitoring in reactor cooling systems, method for failed fuel element location by

REACTOR FUEL ELEMENTS—failure of, coolant monitoring system for detection and location of (H.D.R.)

4178 A METHOD OF AND APPARATUS FOR DIFFERENTIATING BETWEEN AND CLASSIFYING DIFFERENT OPERATING ELEMENTS CONTAINED IN THE CLOSED CYCLE OF A NUCLEAR REACTOR. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,171,389. 19 Nov 1969. Priority date 1 Mar 1966, Germany.

REACTOR FUEL ELEMENTS—burnup in operating, method and apparatus for determination of

REACTORS, PEBBLE BED—core elements for, system for identification and classification of operating fuel and moderator (H.D.R.)

4179 IMPROVEMENTS IN OR RELATING TO PRESSURE VESSELS. Mottram, Anthony William Thomas (to Rolls-Royce Ltd.). British Patent 1,167,488. Oct. 15, 1969. Filed July 17, 1968.

Reference is made to integral nuclear power plants having prestressed concrete pressure vessels. It is desirable that the gas turbine should be readily removable from the pressure vessel for maintenance purposes, and for this purpose the pressure vessel must be provided with a suitable opening. A closure member for such an opening is described which does not substantially detract from the integrity of the pressure vessel as a whole. The pressure vessel is provided with a cylindrical recess, a number of prestressing cables or similar stressing means extending through the pressure vessel in a direction parallel to the axis of the recess, a removable closure member adapted to be secured to at least some of the cables so as to be urged into engagement with the external surface of the pressure vessel, and means for transmitting tension from the cables to the remainder of the pressure vessels when the closure member is removed. (UK)

4180 ASSEMBLIES OF HEAT EXCHANGE ELEMENTS. Boorman, Colin; Betts, Colin (to United Kingdom Atomic Energy Authority). British Patent 1,167,502. Oct. 15, 1969. Filed Nov. 23, 1965.

Reference is made to reactor fuel element assemblies of the cluster type. In such assemblies the fuel rods are usually end supported and spaced by transverse spacer grids. The spacer grid described is of cellular form. The cells have projections adapted to engage and locate an element extending through the cell. The cell is shaped so as to be inclined to the axis of the element and to the plane of the spacer grid in order to promote mixing of coolant in the stream passing through the cell. The arrangement provides efficient heat transfer between the elements and the coolant. Preferably the projections are shaped and arranged so as to impart a rotational movement to the coolant stream. This reduces hot channel factors arising from geometrical tolerances and local fuel element variations and also reduces coolant outlet temperature gradients across the assembly without a prohibitive increase in pressure drop. Opposed rotational movements of the coolant may also be provided for, and an irregular edge may be provided on one side of the grid to promote eddy diffusion in the coolant passing through the grid. (UK)

4181 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Gulf General Atomic Inc.). British Patent 1,170,879. 19 Nov 1969. Priority date 7 Jun 1967, United States.

REACTOR CONTROL ELEMENTS—drive system for, with electromagnetic latch and hydraulic scram insertion (H.D.R.)

GENERAL

4182 (ANL–7621) GEDANKEN: A SIMPLE TYPELESS LANGUAGE WHICH PERMITS FUNCTIONAL DATA STRUCTURES AND COROUTINES. Reynolds, John C. (Argonne National Lab., Ill.). Sep 1969. Contract W-31-109-eng-38. 70p. Dep. CFSTI.

GEDANKEN is a simple, idealized programming language with the following characteristics: (1) Any value which is permitted in some context of the language is permissible in any other meaningful context. In particular, procedures and labels are permissible results of functions and values of variables. (2) Assignment and indirect addressing are formalized by introducing values, called references, which in turn possess other values. The assignment operation always affects the relation between some reference and its value. (3) All compound data structures are treated as functions. (4) Type declarations are not permitted. The functional approach to data structures and the use of references insure that any process which accepts some data structure will accept any logically equivalent structure, regardless of its internal representation. More generally, any data structure may be implicit, i.e., it may be specified by giving an arbitrary algorithm for computing or accessing its components. The existence of label variables permits the construction of coroutines, quasi-parallel processes, and other unorthodox control mechanisms. A variety of programming examples illustrates the generality of the language. Its simplicity is demonstrated by a concise formal definition, in which abstract programs are treated as GEDANKEN data structures, and an interpreter for these structures is given in GEDANKEN itself. (auth)

4183 (ISS–68/47) THE SEMINAR AT THE PHYSICS LABORATORY DURING THE PERIOD SEPTEMBER–DECEMBER 1968. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Dec. 20, 1968. 37p. (In Italian). Dep.

A synopsis of the lectures held at the Physics Laboratory of the Istituto Superiore di Sanità during the period September–December 1968 is presented. (auth)

4184 (LA–4247) TURBULENCE DISTORTION IN A NONUNIFORM TUNNEL. Harlow, Francis H.; Romero, N. C. (Los Alamos Scientific Lab., N. Mex.). Aug. 1969. Contract W-7405-eng-36. 12p. Dep. CFSTI.

Homogeneous turbulence passing through a tunnel of nonuniform cross section is altered in scale, in total energy content, and in the distribution of energy among the directional components. Previous theories have explained the results for rapid distortions of small magnitude, but disagree with experiments in which there are relatively slow distortions of large magnitude. It is shown how computer solutions of the full turbulence transport equations can describe the principal features of all the available experiments. (auth)

4185 (LA–4256) ENTROPY OF INTERACTING POPULATIONS. Everett, C. J.; Ulam, S. M. (Los Alamos Scientific Lab., N. Mex.). Aug. 1969. Contract W-7405-eng-36. 9p. Dep. CFSTI.

A study is made of interacting populations of particles which closely parallels the Boltzmann kinetic theory and the Planck–Einstein–Tolman treatment of radiation interacting with matter. The analogy is perhaps surprising since it appears that our postulates do not embody the physics of such systems, but are nevertheless quite reasonable, and applicable to similar situations. While we have deliberately used the language of physics for its intuitive appeal, one may well consider for example the implications of replacing "particles" by "people" and "energy" by "wealth." It is especially interesting that the "reversibility paradox" is excluded by confining the discussion to a scalar "energy" rather than a vector "velocity." (auth)

4186 (LA–4266) CANTOR-TYPE INTERVAL DISSECTIONS AS RANDOM NUMBER TESTS. Beyer, W. A. (Los Alamos Scientific Lab., N. Mex.). Sep 1969. Contract W-7405-eng-36. 6p. Dep. CFSTI.

Discussion is given of a class of random number tests, in the sense of Kolmogorov's and Martin-Löf's new theory of the von Mises "collective," the members of which are generalizations of Cantor's "middle third" dissection of the unit interval. In the case of Bernoulli trials with success probability $p \geq \frac{1}{2}$, p computable, it is shown that the Hausdorff dimension of the set of nonrandom numbers is not less then $-\log 2/\log (1-p)$. (auth)

4187 (NP–18051) SEVENTEENTH ANNUAL REPORT, 1968–69. (Australian Atomic Energy Commission, Coogee). June 30, 1969. 115p. Dep. CFSTI (U. S. Sales Only).

The organization and research programs of the Australian Atomic Energy Commission for 1968–69 are described. Topics covered include nuclear power, raw materials, research programs in reactors, reactor chemistry, nuclear radiation detectors, radiochemistry and radiation biology; and production of radioisotopes. Peaceful uses of nuclear explosives and regulatory aspects of nuclear energy are also mentioned. Financial accounts, research and training projects, and other administrative matters are outlined. (Australia)

4188 (ORNL–4468) SAMPLE SIZE REQUIREMENTS: TESTS OF EQUALITY OF SEVERAL GAUSSIAN MEANS. Kastenbaum, Marvin A.; Hoel, David G.; Bowman, K. O. (Oak Ridge National Lab., Tenn.). Nov 1969. Contract W-7405-eng-26. 36p. Dep. CFSTI.

Answers to questions concerning adequate sample size in a one-way analysis of variance situation depend on such things as the number of categories to be compared, the levels of risk an experimenter is willing to assume, and some knowledge of the noncentrality parameter. Tables are presented for the experimenter who can deal better intuitively with an estimate of the standardized range of the means than with the noncentrality parameter. Maximum values of the standardized range, τ, are tabulated when the means of k groups, each containing N observations, are being compared at α and β levels of risk, for $\alpha = 0.01, 0.05, 0.1, 0.2$; $\beta = 0.005, 0.01, 0.025, 0.05, 0.1, 0.2, 0.3, 0.4$; k = 2 (1) 6; N = 2 (1) 30 (5) 50 (10) 100 (50) 200 (100) 500 (500) 1000. (auth)

4189 (RFP–1392) A FORTRAN IV PROGRAM FOR ELLIPSOMETER MEASUREMENTS OF SURFACE FILMS. Loser, Robert W.; Larson, Donald T. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Oct. 17, 1969. Contract AT(29-1)-1106. 36p. Dep. CFSTI.

A FORTRAN IV program is presented for use with an ellipsometer to determine the index of refraction of a surface film, the thicknesses of the surface film and the index of refraction of the substrate material. The program processes data taken by an ellipsometer which is used to measure the growth of a surface film. The ellipsometer measurements are described as input data, and refractive index and film thicknesses are described as output data. Included is a brief description of the techniques used to determine refractive index and surface film thicknesses, and a complete description of the FORTRAN IV program. (auth)

4190 (SC-RR–69-734) SELECTED CLOUD CHARACTERISTICS FOR WALLOPS ISLAND, VIRGINIA. Church, H. W. (Sandia Labs., Albuquerque, N. Mex.). Nov 1969. 23p. Dep. CFSTI.

Ten years of weather station surface cloud observations are analyzed in order to obtain a climatological description of occurrences of middle layer stratus type clouds for Wallops Island Missile Range. It is shown that altostratus or nimbostratus clouds were reported about 5 percent of the time in winter, decreasing to 2 percent in summer, while overcast sky was reported 43 percent of the time in February, decreasing to 23 percent in July. (auth)

4191 (SCL-DR–69-98) SHOCK CODE USER'S MANUAL. A COMPUTER CODE TO SOLVE THE DYNAMIC RESPONSE OF LUMPED-MASS SYSTEMS. Gabrielson, V. K.; Reese, R. T. (Sandia Labs., Livermore, Calif.). Nov 1969. Contract AT-(29-1)-789. 86p. Dep. CFSTI.

A user's manual for the SHOCK code is presented. The code was written for the numerical solution of transient dynamic problems which have been modeled as lumped-mass systems. The current CDC 6600 version of the code and the major changes which have resulted since the original report (SCL-DR-65-34) was issued are described. The code is written entirely in FORTRAN and constructed around the 6600 SCOPE operating system. Special emphasis is placed on input data requirements, options for describing nonlinear stiffnesses (springs), and sample problems. (auth)

4192 (STI/DOC–10/74) IAEA RESEARCH CONTRACTS. Seventh Annual Report. Technical Reports Series No. 74. (International Atomic Energy Agency, Vienna (Austria)). 1967. 235p. IAEA $1.00.

Summaries are presented of 52 Research Contract Final Reports received during 1966. The summaries are presented under the following general headings: radioactive waste management and related environmental research, health physics and radiation protection, radiation biology, safeguards methods, studies involving reactors, radioisotope applications in agriculture, radioisotope applications in medicine, radioisotope applications in hydrology, and food preservation by irradiation. (M.C.G.)

4193 (UCRL-50682) AN INTRODUCTION TO THE LRL TEXT EDITING SYSTEM. Fritsch, Frederick N.; Lawrence, J. Dennis (California Univ., Livermore. Lawrence Radiation Lab.). June 11, 1969. 40p. Dep. CFSTI.

The LRL Text Editing System is described beginning with a few historical notes. The structure, capabilities, and implementations of the three basic elements of the system are discussed, including (1) the Publisher—a general-purpose report composition program; (2) Publisher Alter Routine (PubAlt)—a text editing program designed to operate on Publisher input; and (3) CIC chain tape—on overlay chain tape containing PubAlt and Publisher linked to a main control program. The system is written in the LRLTRAN language for the CDC-3600 and the CDC-6600. (W.H.K.)

4194 (UCRL-50739) A THEORETICAL DISCUSSION OF A K-BAND MICROWAVE CAVITY-RESONATOR SPECTROMETER. Hrubesh, Lawrence W.; Anderson, Roger E.; Rinehart, Edgar A. (California Univ., Livermore. Lawrence Radiation Lab.). 29 Aug 1969. 31p. Dep. CFSTI.

A microwave spectrometer, designed specifically for the study of transient molecular species in the gas phase, has been constructed using a Fabry-Perot type resonator as the absorption cell. Such a system can be shown to have a theoretical sensitivity comparable to the most sensitive,waveguide-cell spectrometers. The theory of a gas-filled resonator is discussed, the optimization of the inherent characteristics of such a resonator, particularly its sensitivity is considered. It is shown that for nearly optimum conditions, the K-band cavity-resonator spectrometer is capable of measuring absorptions as weak as 0.23×10^{-11} cm^{-1} with simple homodyne detection techniques. (auth)

4195 (UCRL-50746) DESIGN AND PERFORMANCE CHARACTERISTICS OF A PASSIVE FIN CALORIMETER. Cooper, Thomas E. (California Univ., Livermore. Lawrence Radiation Lab.). July 7, 1969. 35p. Dep. CFSTI.

The theoretical and experimental results of a parametric study of various designs for a passive fin calorimeter are presented. Designs are presented which have a capability of determining energy levels to within an estimated ±5% accuracy. Temperature-sensing paints are applied in long, thin strips to the fin section of the calorimeter and serve as a passive form of instrumentation. The fin calorimeter is designed so that only partial melt is realized on many of the paint strips after energy input, thus allowing the calorimeter to serve as its own control. This facilitates interpretation and increases accuracy. Airbrush application of the temperature-sensing paints give a texture and thickness which is superior to the application of paints with a brush or an aerosol can. (auth)

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Elmar R. Reiter, Colorado State University,
Fort Collins, Colorado

December 1969

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